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Abstract

This paper examines the association between monetary policy and stock market booms and busts in the United States, United Kingdom, and Germany during the 20th century. Booms tended to arise when output growth was rapid and inflation was low, and end within a few months of an increase in inflation and monetary policy tightening. Latent variable VAR analysis of post-war data finds that inflation has had a particularly strong impact on market conditions, with disinflation shocks moving the market toward a boom and positive inflation shocks moving the market toward a bust. We conclude that central banks can contribute to financial market stability by minimizing unanticipated changes in inflation.

I. **Introduction**

The association between monetary policy and the performance of stock and other asset markets has long piqued the interest of economists and policymakers. Stocks are claims on real assets and, hence, monetary neutrality implies that monetary policy should not affect real stock prices in the long run. However, researchers have found considerable evidence that monetary policy can affect real stock prices in the short run (e.g., Bernanke and Kuttner, 2005), and have conjectured that the nature of the monetary policy regime can affect the performance of asset markets over longer horizons.

Some economists argue, for example, that monetary policies that result in persistent or highly variable inflation destabilize financial markets (e.g., Schwartz, 1995). Historically, U.S. stock returns have been negatively correlated with inflation (Fama and Schwert, 1977). Goodfriend (2003) argues that the policies followed by the Federal Reserve and other central banks before 1980 were an important source of both macroeconomic and financial instability, which could explain why real stock prices and inflation were negatively correlated. Higher inflation, for example, would tend to depress stock returns because higher expected inflation would raise long-term interest rates (and thereby raise the rate at which investors discount future dividends) and because monetary policy actions to limit inflation would tend to slow economic activity (and thereby depress current and forecast earnings). Goodfriend (2003) argues that, by contrast, asset prices would not respond to specific policy actions under policy rules that maintain a stable price level. Such rules are thought by some to lessen the chance of asset price bubbles (e.g., Woodford, 2003), though other economists contend that inflation stabilization can foster imbalances that lead to bubbles (e.g., Borio and Lowe, 2002).

The stock and real estate market booms of the 1990s and first years of the 21st century also raised questions about the efficacy of using monetary policy to resist asset price booms. Some economists argue that financial markets are inherently volatile, that market prices often stray from fundamentals, and that bubbles are common. They suggest that policymakers could improve welfare by attempting to deflate asset price booms, especially if sudden declines in asset prices are likely to depress economic activity (e.g., Cecchetti et al., 2000).[1] Other economists contend that financial markets process information efficiently. These economists tend to believe that policymakers usually cannot determine when assets are mispriced and, hence, that they cannot enhance aggregate welfare by reacting to asset price movements (e.g., Bernanke and Gertler, 1999; 2001).

The purpose of this paper is to marshal evidence on the association between monetary policy and stock market booms and busts by studying the experiences of three major developed countries – the United States, United Kingdom, and Germany – over the 20th century.[2] The experiences of these countries are interesting because of their varied policy and stock market histories. We construct monthly real (i.e., inflation-adjusted) stock price indexes for the United States, United Kingdom and Germany. We then identify extended periods of unusually rapid appreciation in the real indexes for each country, which we define as booms, and periods of large decline, which we define as busts. We investigate the circumstances under which stock market booms arose and collapsed, focusing especially on

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[1] Rapid growth of asset prices amid low consumer price inflation renewed interest in the question whether monetary policy should target measures of inflation that include asset prices as well as consumer prices. Proponents of broader inflation measures include Goodhart and Hofmann (2000) and Bryan, Cecchetti, and O'Sullivan (2002).

[2] Bordo and Wheelock (2006; 2007) examine informally the conditions under which 20th century U.S. stock market booms occurred and ended and compare the U.S. experiences with those of nine other countries, including Germany and the United Kingdom. Those studies find that stock market booms typically arose during periods of above-average output growth and below-average inflation, and that booms almost always ended after a period of monetary policy tightening.

the role of monetary policy in promoting or ending booms. Although we do not address directly the extent to which booms were characterized by stock price bubbles, we provide some evidence on this issue by investigating whether booms arose during periods of strong macroeconomic conditions, such as high output growth and low inflation.

Across all three countries, and for both the interwar and post-World War II periods, we find that typically stock market booms were associated with the business cycle, arising when real output growth was above average and ending as output growth slowed. We also find that booms tended to arise when consumer price inflation was low and end after a period of monetary policy tightening associated with an actual or threatened rise in inflation. These patterns differ little across time, and therefore across the different policy regimes in place over the 20th century.

For the post-World War II period, we estimate a latent-variable vector autoregression (Qual-VAR) model to investigate in more depth the impact of shocks to policy and other variables on real stock prices and the condition of the stock market.[3] The Qual-VAR is uniquely suited to studying experiences that fall outside the norm, such as stock market booms and busts, that comprise relatively little of the overall sample variance of stock price movements. Thus, the Qual-VAR provides evidence about whether relationships observed during booms or busts differ from those of periods that could be characterized as normal. Further, unlike the basic Qual-VAR, our approach allows the data to partly determine the identification of boom and bust states which lessens the influence of potentially erroneous

[3] Although data for the United States and United Kingdom are available for the interwar period, the interwar era is both short for estimation of time series models and dominated by the Great Depression. The Depression and marked changes in policy regimes that resulted from the Depression make estimation of our Qual-VAR for the interwar period impractical.

judgments of the researcher about market conditions.[4] From the Qual-VAR estimation we find that inflation shocks have had a significant impact on the stock markets of all three countries, with disinflation shocks promoting booms and inflation shocks promoting busts. Interest rate shocks also have had a large impact, with unexpected increases in the long-term interest rate pushing the market toward a bust and unexpected rate declines moving the market toward a boom. Finally, we find that shocks to U.S. stock market conditions have had a significant, positive impact on the condition of the U.K. and German stock markets.

Section II describes the interaction of monetary policy and stock prices in the three countries during the interwar period**.** Section III presents similar information for the post-war period. Section IV describes our hybrid Qual-VAR model. Section V presents econometric results and Section VI concludes.

II. Monetary Policy and Stock Prices During the Interwar Period

The economic and political histories of the United States, United Kingdom, and especially Germany during the interwar period differed radically across the countries. The United States was comparatively unscathed by World War I and emerged as the world's leading economic power. Except for a brief embargo on gold exports during the war, the United States remained on the gold standard and held ample reserves to defend its pre-war parity. The war was much more costly for the United Kingdom, which left the gold standard de facto and lost its status as the world's leading economic power. The war left Germany utterly defeated and in financial and economic chaos that degenerated into hyperinflation. By the mid-1920s, however, the economies of all three countries were recovering and prices on their stock markets were rising rapidly. The United States had the most rapid and

[4] The Qual-VAR has also been used to examine recessions, where researchers are interested in estimating economic relationships during periods of unusually weak activity that nonetheless account for relatively little of the overall sample variation of output (Dueker, 2005; Dueker and Nelson, 2006).

prolonged rise of stock prices during the 1920s, but U.K. share prices also rose at rates that were above the historical norm. Germany experienced a period of rapidly rising share prices in the mid-1920s after inflation had been controlled.

Although not nearly as severe as the German hyperinflation, both the United States and United Kingdom experienced rapid inflation from the end of World War I through mid-1920. Figures 1 and 2 show that in both countries real, i.e., inflation-adjusted, stock prices reached their low points in late 1920 and then began to rise sharply as consumer prices came down.[5] The turning point in the U.S. stock market coincided closely with the recovery of economic activity from a recession in 1920-21, as shown in Figure 3. U.K. stock prices began to rise somewhat before the start of the business expansion, as reflected in *The Economist* index of business activity (Figure 4).[6] In both countries, the upward trend of share prices over the remainder of the decade coincided with long-run expansion of real activity.

In real terms, U.K. share prices rose at an average annual rate of 7.4 percent between May 1925, when pound convertibility was restored, and August 1929. Over the same period, U.S. real stock prices rose at an average rate of 25.4 percent. The slower growth of U.K. stock prices mirrored the slower rate of output growth and generally tighter monetary policy of the United Kingdom. The United Kingdom underwent a larger post-war deflation than the United States, and maintained a more restrictive monetary policy after gold convertibility of the pound was restored in May 1925 that resulted in modest deflation from 1925 to 1929. The Bank of England held policy tight in an effort to defend the gold standard in the face of

[5] See the appendix for descriptions of the data used in this paper and for source information.
[6] The U.K. experienced a sharp, though brief, drop in output in early 1921 and a second dramatic fall in output in 1926 associated with the six month strike of mine workers and a nine day general strike.

doubts about the viability of the exchange rate peg that discouraged capital inflows and also kept a brake on share prices.[7]

Germany experienced a short, but steep stock market boom during 1926-27. In real terms, German stock prices rose at an average annual rate of 77.9 percent between January 1926 and April 1927, when stock prices peaked. The boom arose during a period of rapid GDP growth and stable consumer prices, as shown in Figure 5. Unlike peaks in the U.S. and U.K. stock markets, the peak in German real stock prices did not coincide with a business cycle peak but preceded it. However, the end of the German boom, like the ends of the U.S. and U.K. booms, did follow a tightening of monetary policy.

As the U.S. boom progressed, Federal Reserve officials became increasingly concerned about the expanding volume of loans used to finance stock market purchases and the possibility that Federal Reserve credit was being used to support that growth. Many Fed officials believed that stock market speculation and rising equity prices would ultimately lead to more general inflation (Meltzer, 2003). For example, Federal Reserve Board member Adolph Miller argued that the rapid growth of stock exchange loans reflected excessively loose monetary policy that had expanded bank reserves and credit when "business could not use, and was not asking for increased money."[8] Although Miller's views were not shared universally within the Fed, by 1928 most Fed officials agreed that tighter policies were necessary to reign in the stock market boom.

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[7] The efforts of the Bank of England to maintain the gold standard and the extent to which it was assisted or hindered by the monetary policies of other countries has been the focus of much research. See Eichengreen (1992) and references therein.

[8] Testifying before the Senate Banking Committee in 1931 (quoted in Wheelock, 1991, pp. 98-99). Recent proponents of the view that the stock market boom reflected a credit boom include Rothbard (1983) and Eichengreen and Mitchener (2004). Bordo and Wheelock (2004) find that neither the money stock nor total bank credit grew unusually rapidly during the boom, though the volume of brokers loans expanded rapidly and in line with stock prices.

The Federal Reserve adopted a tight policy in early 1928, which it maintained until the market crash in October 1929 in an effort to choke off the flow of credit to the market.[9] This policy was reflected in both a slowing of money stock growth and a sharp increase in interest rates. As shown in Figure 6, money stock growth had slowed to a halt by mid-1928 and was essentially unchanged through August 1929. The commercial paper interest rate rose some 200 basis points over the same period, as shown in Figure 7.[10]

The U.K. and German stock market booms also ended following a tightening of monetary policy. The timing of the U.K. boom and crash coincided closely with the U.S. boom and crash, reflecting the high degree of capital mobility among gold standard countries in the 1920s. Thus tight monetary policy in the United States, which produced capital outflows from Great Britain to the United States, induced the Bank of England to raise its Bank Rate in response to declining gold reserves (Eichengreen, 1992). As in the United States, U.K. money stock growth slowed and short-term interest rates increased sharply before the collapse of real stock prices in October 1929.

In Germany, the Reichsbank's reaction to stock market speculation was similar to that of the Federal Reserve in the United States. Voth (2003) shows that Reichsbank Governor Hjalmar Schacht was convinced that German stock prices far exceeded fundamental value and worried that credit was being diverted to stock market speculation that otherwise could be used to fund productive investment. Further, Voth (2003) argues, actions by the Reichsbank to limit the flow of credit to the stock market were directly responsible for the

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[9] See Friedman and Schwartz (1963), Meltzer (2003), Wheelock (1991) and Wicker (2006) for discussion and evidence on the Fed's reaction to stock market speculation.

[10] Based largely on the slowing of money stock growth, Schwartz (1981) and Hamilton (1987) argue that monetary policy tightened significantly during 1928-29 and hastened the stock market crash and subsequent depression. Wicker (2006) contends, however, that policy was close to neutral.

market crash in May 1927. Thus, as in the United States and United Kingdom, the stock market peak was preceded by explicit tightening of monetary policy.

In sum, the stock market booms of the United States, United Kingdom, and Germany during the 1920s all arose as economic activity was expanding and after inflation had been brought under control. The booms of all three countries ended following a tightening of monetary conditions which in the United States and Germany was aimed primarily at limiting the flow of funds to the stock market. This tightening in turn reflected fears that the stock market boom would lead to inflation.

III. Real Stock Prices During the Postwar Period

The Great Depression led to new regulations on financial markets that were strengthened during World War II, especially in Europe, to include restrictions on the issuance of private securities and the movement of capital across international borders. Wartime controls were gradually relaxed, but deregulation was protracted. The pace of deregulation picked up in the 1970s when rising inflation distorted or undermined many regulations, such as interest ceilings**,** and increased in the 1980s as countries sought to keep their financial markets competitive in the face of advances in information-processing technology that encouraged financial innovation and globalization.

The monetary policy environment was also much changed by the Great Depression and war. The Depression effectively ended the international gold standard as countries either abandoned the standard altogether or imposed exchange controls that limited its functioning (Eichengreen, 1992). After the war, the international monetary system was re-constituted under the Bretton Woods System of adjustable pegged exchange rates and capital controls. The System collapsed in the early 1970s under the weight of rising inflation and misaligned

exchange rates. The U.S. dollar then floated while most of the major European currencies remained linked to one another through various exchange rate mechanisms. In 1999, the monetary systems of several European countries, including Germany but not the United Kingdom, became fully integrated within the European Monetary Union (Bordo and Schwartz, 1999).

The real stock price indexes for the United States, United Kingdom and Germany from 1948 to 2004, all normalized to 1.0 in January 1948, are shown in Figure 8. U.S. stock prices rose rapidly throughout much of the 1950s, especially after the Korean War, through the mid-1960s. The German stock price index also rose rapidly during the 1950s, outpacing the U.K. index, especially in the second half of the decade.

Real stock returns stalled in the early 1960s as inflation began to rise. Both the German and U.K. indexes peaked in real terms in 1960-61, while the U.S. index continued its upward trend to 1966. Real returns were abysmal during the 1970s, especially for the U.S. and U.K. markets. The United Kingdom suffered the highest average inflation rate among the three countries during the 1970s, as shown in Figure 9, and the largest decline in real stock prices, followed by the United States. Germany, by contrast, had relatively low inflation during the 1970s and the highest real stock returns among the three countries. Real stock prices rose in all three countries when inflation declined in the early 1980s, and then again in the late 1990s when inflation was low and stable.

The rise in U.S. stock prices during the late 1990s was especially rapid, and though prices of information-technology company stocks rose the most, the boom was broadly based. The boom arose during a period of increased productivity growth, which many observers hailed as evidence of a “new economy” that justified rapid appreciation of equity

prices by foreshadowing strong growth of economic activity and corporate profits. The period was also marked by low and stable inflation which may have contributed to the boom by reflecting stable macroeconomic policies. Some analysts have argued, however, that the rapid rise in equity prices was a manifestation of loose monetary policy that happened to generate asset price inflation rather than consumer price inflation. The end of the boom did coincide with a tightening of monetary policy. This tightening seems to have been in response to rising consumer price inflation and inflation expectations, though some studies conclude that the Fed also sought to contain the booming stock market.[11]

Bordo and Wheelock (2007) find that the macroeconomic conditions under which earlier postwar U.S. stock market booms had arisen were similar to those of the 1994-2000 boom and broadly similar to those of booms in other industrial countries. Output growth tended to be higher than average during booms, while inflation was below average, and most booms ended following a tightening of monetary policy. In the following section we present econometric evidence on the impacts of macroeconomic and monetary policy shocks on real stock prices and stock market conditions for the United States, United Kingdom and Germany over the postwar period.

IV. Monetary Policy and Stock Market Booms and Busts in the Postwar Period

We investigate further the association of stock market booms and busts with macroeconomic and monetary policy conditions by estimating a latent variable vector autoregression (Qual-VAR) on post-war data for the United States, United Kingdom, and Germany.

[11] For contrasting views on whether the Fed adjusted policy in response to the stock market during this period, see Cecchetti (2003), Rigobon and Sack (2003), Hayford and Malliaris (2004), and Meyer (2004).

The Qual-VAR approach enables us to examine the impact of shocks to real economic activity, inflation and policy variables on real stock prices as well as on the condition of the stock market. Relatively little of the overall sample variance of stock returns occurs during booms or busts because those episodes occur infrequently. Hence, estimates from models that do not account for the condition of the market will be heavily influenced by data from normal periods. The Qual-VAR can provide evidence about whether the relationships we observe during booms and busts differ from those of periods that could be characterized as normal.

A potential drawback of the basic Qual-VAR approach to modeling stock market booms and busts stems from its reliance on the subjective determination by the researcher of when the market is in a boom or bust state.[12] We define booms as long periods of high average real market price appreciation and busts as extended periods of rapid decline. In doing so, we choose arbitrary cutoffs for the length of time and rate of change in the stock price index that define booms and busts. Although we believe our choices are reasonable, we use a hybrid approach described below that makes the determination of market conditions at least partly endogenous.

Econometric Model

In making use of a constructed chronology of financial booms and busts, one has to decide how heavily to rely on the judgmental dates. If they are given full credence, a multivariate dynamic ordered probit approach, such as the Qual-VAR from Dueker (2005) and Dueker and Nelson (2006), would treat the constructed chronology as part of the data. To fix ideas, consider a generic unobserved component state-space model with the following

[12] See Harding and Pagan (2006) for warnings about working with constructed classifications.

state equation, where X are the observable variables and z is the latent unobserved component:

$$\begin{pmatrix} X_t \\ z_t \\ z_{t-1} \end{pmatrix} = \begin{pmatrix} c_X \\ c_z \\ 0 \end{pmatrix} + \begin{pmatrix} \Phi_{XX} & \Phi_{Xz} & 0 \\ \Phi_{zX} & \Phi_{zz} & 0 \\ 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} X_{t-1} \\ z_{t-1} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{X,t} \\ \varepsilon_{z,t} \\ 0 \end{pmatrix} \quad (1)$$

The measurement equation is

$$X_t = \begin{pmatrix} I & 0 & 0 \end{pmatrix} \begin{pmatrix} X_t \\ z_t \\ z_{t-1} \end{pmatrix} \quad (2)$$

As an example of the Qual-VAR approach, consider the following relationship between the latent variable and the three categories of stock market conditions:

$$\begin{aligned} \textit{bust state iff} \quad & z_t < c_1 \\ \textit{normal state iff} \quad & c_1 \le z_t < c_2 \\ \textit{boom state iff} \quad & z_t > c_2 \end{aligned}$$

The constants c_1, c_2 are estimated and serve as truncation limits for the latent variable, based on the three categories of stock market conditions. Imposing these truncation limits on the latent variable is tantamount to treating the boom/bust classifications as data. This approach is used in the Qual-VAR model, which is a multivariate dynamic probit in which a continuous latent variable lies behind observed qualitative categories. Alternatively, the unobserved components model in equations (1) and (2) can be a dynamic factor model in which the latent variable takes on whatever values best explain the observed data vector X over time.

In this paper, we adopt a hybrid approach that bridges the dynamic ordered probit model and the dynamic factor model. The hybrid approach consists of running two state-space models in parallel. The first is a Qual-VAR model that imposes the truncation limits on the latent variable implied by our posited boom/bust classifications. The second model ignores our boom/bust classifications and amounts to a dynamic factor model. In both cases, the state-space form is that of equations (1) and (2). The only difference between the dynamic probit and dynamic factor versions is whether truncation limits are imposed on the latent variable. The Qual-VAR model (dynamic probit) is used to generate a vector of mean values for the latent variable; to obtain the sampled values the vector is then randomized around the Qual-VAR means using the variance implied by the dynamic factor (non-truncated) model:

$$\textit{sampled value} \quad z_t = \bar{z}_t^{DP} + \sigma_t^{DF} e_t$$

where DP denotes a value implied by the dynamic probit model and DF refers to the dynamic factor model and e is a standard normal shock. In this way, the sampled value of the latent variable does not have to conform to the truncation limits. In keeping with the Bayesian nature of the estimation procedure outlined here, note that one can easily scale the variances up or down. A scaling factor less than one reflects a greater degree of confidence in the judgmental categories, which amounts to a stronger prior on their relevance. Similarly, a scaling factor greater than one amounts to a weaker prior on the judgmental categories. We set the scaling factor to 1.0, which we consider to be a neutral baseline value, to generate the results presented here.

A key property of the hybrid procedure is that the draws of the latent variable can lie outside the truncation limits and so the model-implied category for a given observation can

differ from the judgmental category assigned to it by the researcher. Nevertheless, unlike the dynamic factor model, by centering the randomization of the latent variable at values that are implied by the judgmental categories, the latent variable is tailored to reflect the judgmental categories on average across the sample period. In this way, the hybrid dynamic factor / dynamic probit model helps overcome the "what does the factor represent?" question that hinders interpretation of dynamic factor models. At the same time, however, the hybrid model also addresses concerns about the accuracy with which the researcher assigned observations to particular categories.

We estimate our hybrid model using a Bayesian Markov Chain Monte Carlo estimation procedure in which the randomized values of the latent variable are treated as a proposal value in a Metropolis-Hastings step. This proposal draw is either accepted or rejected depending on how the draw fits the data density.[13] The proposal density has the mean implied by the Qual-VAR dynamic probit and the variance implied by the dynamic factor model. The data density is derived from the forecast errors for the observed data X conditional on a vector of values for the latent variable z. According to the Metropolis-Hastings sampling algorithm for the latent variable, the proposal value is accepted with probability

$$\alpha\left(z^{new}\right) = \min\left\{\frac{g\left(z^{old}\right) f_T\left(X \middle| z^{new}\right)}{g\left(z^{new}\right) f_T\left(X \middle| z^{old}\right)}, 1\right\}$$

The current value z^{old} is retained if the proposal value is rejected by a uniform draw on the unit interval, where the acceptance probability is α, g is the proposal density for the latent

[13] See Chib and Greenberg (1995) for details about the estimation procedure.

variable vector and f is the target density for the data conditional on a set of values for the latent variable.

Probit models are nonlinear regressions. Even though we are working in a vector autoregression framework, the latent variable leads to a nonlinear response of the macroeconomic variables to a change in stock prices. If a change in stock prices is associated with a change in market conditions, say from normal to boom, then the effect is magnified (or possibly dampened) relative to a change in stock prices of the same size that is not associated with a change in conditions. This nonlinearity arises because the latent variable is relatively constant within each category of market conditions but undergoes sizable jumps between categories.

Data and Model Specification

We use the hybrid Qual-VAR to estimate the effects of output, inflation, and other shocks on the latent variable representing the condition of the stock market. We define booms as long periods of unusually rapid increase in the real stock price index, busts as extended periods of rapid decline in the index, and normal conditions as prevailing in all other periods. We estimate our model using post-war data for the United States, United Kingdom and Germany.

We identify booms and busts using the approach of Pagan and Sossounov (2003). First, we calculate a monthly index of real stock prices for each country by deflating a nominal stock price index by a consumer price index. Next, we identify real stock price index peaks and troughs within rolling, 25-month windows. We require that peaks and troughs alternate and so eliminate all but the highest maximum that occurred before a subsequent trough and all but the lowest minimum that occurred before a subsequent peak.

We classify as booms all periods of at least 36 months from trough to peak with an average annual rate of increase in the real stock price index of at least 10 percent or of at least 24 months with an annual rate of increase of at least 20 percent.[14] We define market busts as all periods of at least 12 months from a market peak to a market trough in which the index declined at an average rate of at least 20 percent per year. Following Pagan and Sossounov (2003), we also treat the 1987 stock market crash as a bust even though in all three countries the stock market decline lasted for less than 12 months. Similarly, we also treat the 10-month decline in the U.S. stock market in 1966 as a bust. The boom and bust periods we identify for use in our econometric analysis, alongside the average annual percentage change in the real stock price during each episode, are shown in Table 1. As noted above, our estimation procedure uses the boom and bust periods we identify as starting values, but the implied classifications for individual periods are determined endogenously by fitting the model to the data which thereby reduces the extent to which our estimation results are driven by our personal judgments about how to define booms and busts.

V. Estimation Results

First we compare model-based estimates of the latent market conditions variable with the categories we identified *a priori*. Our judgmental categories guide the sampling of the latent variable but some percentage of the Markov Chain Monte Carlo draws for a given observation will imply a different classification than the one we chose. Although we allow the data to speak, Figures 10, 11 and 12 show that for the United States the model-implied draws of the latent variable generally conform to the categories we identified.[15]

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[14] Over the entire period 1947-2004, the real stock price indexes for the United States and United Kingdom rose at average annual rates of 4.4 percent and 2.8 percent. Over the period 1950-2004, the real stock price index for Germany rose at an average annual rate of 6.0 percent.

[15] We find similarly close conformity for the United Kingdom and Germany.

The hybrid Qual-VAR model allows us to present results through familiar vector autoregression tools such as impulse responses and variance decompositions. These tools are available once we specify an ordering of the VAR variables. The selected ordering also permits us to conduct counterfactual analysis by way of shutting down one structural shock at a time and then calculating counterfactual histories of the model variables. In doing so, we can investigate the extent to which stock market conditions would have differed over our sample period in the absence of various shocks.

In order to apply standard VAR tools to our hybrid model, we identify shocks through the following ordering of the variables: (log) industrial production, inflation, money stock growth, long-term Treasury yield, short-term interest rate, real stock price index, and the latent stock market variable (z), representing market conditions. For the United Kingdom and Germany, we also include the latent market conditions variable for the United States, ordered after the domestic short-term interest rate. The variables are ordered so that variables that are pre-determined to a great extent appear first. Shock measures for variables ordered last condition on a greater number of forecast errors and therefore ought to be cleaner. We use monthly data for the United States and Germany, and quarterly data for the United Kingdom. The estimation periods are August 1952 – December 2005 for the United States, January 1960 – May 2005 for Germany, and second quarter 1963 – second quarter 2005 for the United Kingdom.[16] We use six lags in the Qual-VAR autoregressions.

[16] We use quarterly data for the United Kingdom because we were unable to obtain monthly money stock data for the entire period. The starting dates for Germany and the United Kingdom were dictated by the beginning of monthly or quarterly observations on a consistent money stock series. See the appendix for additional details about the data including source information.

Results for the United States

Figure 13 presents impulse responses of the U.S. real stock price index (S&P 500) and stock market conditions for output (industrial production) and inflation shocks. The figures show point estimates and the bounds of two standard deviations on either side of the point estimates. The initial impacts of output shocks on the real stock price index and on market conditions are both positive, but die out quickly and are not statistically significant. By comparison, inflation shocks have a negative, statistically significant and persistent impact on both the real stock market index and market conditions. Not only do positive inflation shocks reduce real stock prices, they also move market conditions away from boom and normal states toward busts. Moreover, the impact on market conditions appears to induce further decline in real stock prices. In a simple VAR model that does not include the latent stock market conditions index, inflation shocks account for only 25 percent of the variance of the real stock price at a 36 month horizon – a horizon at which the central bank is certainly responsible for the thrust of inflation shocks. However, in the hybrid Qual-VAR model, which allows both a direct effect of inflation on stock prices and an indirect effect via market conditions, inflation shocks account for almost 33 percent of the variance of real stock prices. Thus, our latent variable approach captures a quantitatively important channel by which inflation shocks affect real stock prices through their impact on market conditions.

Figure 14 shows the impacts of shocks to money stock growth and interest rates on the U.S. stock market index and market conditions. Money stock growth shocks do not have a statistically significant impact on the market. However, shocks to the long-term interest rate have a negative, statistically-significant and persistent impact on the real stock price index. The estimated impact on market conditions is also negative, though statistically

significant only for the first three months. Rising interest rates can depress stock prices by raising the rate at which investors discount future earnings and/or by reducing the growth rate of earnings, and thus it is not surprising to find that interest rate shocks tend to reduce stock prices and push the market away from boom conditions. Finally, controlling for shocks to the long-rate, we find that the initial impact of short-term interest rate shocks on real stock prices is negative (though not statistically significant) whereas the initial impact on market conditions is positive. Over the long-run, however, short-term interest rate shocks have a negative impact on both the real stock price and market conditions.[17]

Next we simulate U.S. stock market conditions over the estimation period by shutting down shocks to output, inflation, and the long-term interest rate. Figure 15 shows that output shocks have had little impact on U.S. stock market conditions, as the simulated path of market conditions is nearly identical to the actual path of the latent variable. Inflation shocks have had a more pronounced effect on the market. Figure 16 shows, for example, that stock market conditions would have been stronger in the early 1990s but weaker later in the decade in the absence of inflation shocks. U.S. consumer price inflation spiked following a sharp increase in energy prices at the start of the Gulf War in 1990. Although inflation then fell, it remained above historical norms and higher than one might forecast given the stance of monetary policy.[18] Our counterfactual series indicates that positive inflation shocks kept a

[17] We find the impact of short-term interest rate shocks to be somewhat sensitive to whether the short-term interest rate is ordered before or after the long-term interest rate in the Qual-VAR as well as to the estimation period. Short-term interest rate shocks are found to have a stronger negative impact on stock prices if the short-term rate is placed before the long-term rate in the variable ordering, and also when the estimation is restricted to the post-1980 period. It should be noted, of course, that shocks to short-term interest rates capture idiosyncratic movements and not the endogenous response of interest rates or monetary policy to inflation, output or stock prices.

[18] In an op-ed article in the *Wall Street Journal* on 23 October 1992, Milton Friedman argued that "monetary policy has been extremely tight, not easy, in the U.S." Noting that M2 growth had fallen below 2 percent during the prior four quarters, Friedman argued that "continuation of M2 growth at 2% per year would imply actual deflation, not negligible inflation." In the event, inflation remained between 2.5 and 3 percent until 1997.

lid on the stock market before 1995. Further decline in the inflation rate in the mid-1990s, however, appears to have promoted a boom state during 1995-99 according to our counterfactual.

Inflation shocks were also important for U.S. market conditions at other times over our sample period. For example, our counterfactual indicates that lower-than-expected inflation contributed strongly to the robust stock market conditions of 1953-56, whereas higher-than-expected inflation contributed to the weak market conditions of 1973-75. Further, we find that stock market conditions would have been decidedly weaker in the absence of shocks associated with disinflation in the early 1980s.

Figure 17 presents a counterfactual path for market conditions in the absence of shocks to the long-term Treasury yield. The counterfactual series indicates, for example, that market conditions would have been stronger in the absence of positive interest rate shocks during 1978-81, especially after the abrupt tightening of monetary policy in October 1979. However, negative interest rate shocks can help account for the robust stock market conditions of the mid-1980s and late 1990s. Thus, our results indicate that unanticipated changes in inflation and interest rates were important determinants of both real stock prices and market conditions over the post-war era.

Results for the United Kingdom and Germany

Impulse responses for the United Kingdom are shown in Figures 18-19. Output shocks have a negligible impact on U.K. real stock prices and a small negative impact on market conditions. Inflation shocks also have a negative impact on the market, with positive shocks pushing the market away from a boom toward a bust. We also find that shocks to U.S. stock market conditions have positive impacts on both U.K. real stock prices and market

conditions that are statistically significant over three to four quarters. Accordingly, shocks to U.S. stock market conditions account for up to 25 percent of the forecast error variance in U.K. stock market conditions, depending on the horizon.

Similar to the U.S. market, we find that long-term interest rate shocks have a negative, statistically significant and persistent impact on both U.K. stock prices and market conditions. Unanticipated increases in long-term interest rates depress market prices and move market conditions toward a bust. Money supply and short-term interest rate shocks, by contrast, have little impact on the U.K. market.

Figures 20-23 present counterfactuals that indicate the role of various shocks on the history of U.K. market conditions over the sample period. Figure 21 shows, for example, that U.K. stock market conditions would have been more robust in the mid-1970s were it not for unanticipated increases in inflation, whereas disinflationary shocks contributed to the market boom of the mid-1980s. Inflation shocks appear to explain little of the 1990s stock market boom in the United Kingdom, in contrast to the U.S. boom, though we find that stock market conditions would have been weaker in 2002-04 in the absence of lower-than-expected inflation.

Although inflation shocks *per se* explain little of the U.K. stock market boom of the 1990s, declining expected inflation may have played a role. The United Kingdom adopted an inflation-targeting monetary policy in October 1992. The Bank of England subsequently tightened monetary policy in 1994 to preempt an expected increase in inflation. Although the Chancellor of the Exchequer vetoed additional tightening desired by the Bank in 1995, lower inflation and a slowing of economic activity appear to have contributed to sharp declines in expected inflation and long-term interest rates in 1995-96 that were reinforced

when the Bank of England was granted independence in 1997.[19] Our counterfactual indicates that shocks to the long-term interest rate explain much of the 1990s stock market boom in the United Kingdom, as shown in Figure 22, suggesting that the changes in monetary policy may have played an important role in the boom.

In addition to falling interest rates, shocks to U.S. stock market conditions also help explain the U.K. boom in the 1990s and subsequent bust, as shown in Figure 23. U.S. market conditions also appear to have had a major effect in 1987. Our counterfactual suggests that the U.S. market crash fully accounts for the deterioration of U.K. market conditions in the fourth quarter of 1987.

Impulse responses for Germany are shown in Figures 24 and 25. Output shocks have little near-term impact on German stock prices or market conditions and seemingly have a negative impact over longer horizons. Inflation shocks have a negative impact on German real stock prices and market conditions, though only some six months after the shock. To the extent that German monetary policy resembled nominal income targeting for much of the sample period, it is perhaps not surprising that output and inflation shocks produce a similar stock market response since monetary policy would respond similarly to either type of shock.

We find that shocks to U.S. stock market conditions have an immediate, positive impact on both German real stock prices and market conditions, similar to their impact on the U.K. market. However, through a variance decomposition we find that U.S. stock market conditions account for at most 8 percent of the forecast error variance of German stock market conditions, as opposed to 25 percent for U.K. stock market conditions.

Similar to the United States and United Kingdom, we find that shocks to long-term interest rates have a negative, statistically significant and persistent impact on both German

[19] See Mishkin and Posen (1997) for an evaluation of U.K. monetary policy during 1992-97.

stock prices and market conditions. Money supply shocks, by contrast, have a brief positive impact on market conditions followed by a negative impact over longer horizons, whereas short-term interest rate shocks have a negative impact on the real stock price, but minimal impact on market conditions.

Figures 26-29 illustrate the effects of various shocks on German stock market conditions over the sample period. Output and inflation shocks appear to explain relatively little of the history of German stock market conditions over the sample period. Long-term interest rate shocks explain somewhat more. For example, our estimates suggest that market conditions would have been worse in the absence of negative interest rate shocks during 1975-78. By contrast, market conditions would have been stronger, i.e., more toward a boom state, in the absence of subsequent positive rate shocks during 1980-81. Similarly, in the absence of positive interest rate shocks the market would have been stronger in the early 1990s, whereas negative shocks appear to have boosted market conditions in the late 1990s similar to their impact in the United Kingdom. Finally, the counterfactual series plotted in Figure 29 suggests that shocks to U.S. stock market conditions account for little of the German stock market boom in the 1990s. However, German stock market conditions would have been somewhat stronger beginning in 2000 in the absence of negative shocks to U.S. market conditions.

VI. Conclusion

Twentieth century stock market booms and busts in the United States, United Kingdom, and Germany were closely associated with inflation and monetary policy actions to halt inflation or speculation. Booms arose in all three countries in the 1920s after inflation was brought under control and output began to grow. The U.S. boom was stronger than the U.K. boom, reflecting more rapid output growth and less restrictive monetary policy in the

United States. Germany experienced a strong, but short-lived boom that was snuffed out by a tightening of monetary policy aimed squarely at halting speculative activity. The U.S. boom similarly ended after the Federal Reserve attempted to engineer a policy that brought speculation under control without choking off the supply of credit for the rest of the economy.

In the decades following the Great Depression and World War II, there was again a close relationship between inflation and stock market conditions. Stock market booms tended to arise during periods of low inflation and end following an increase in the rate of inflation and rising interest rates. Some were followed by outright market busts.

Our econometric analysis on post-war data for the United States, United Kingdom and Germany provides further insights about the environments in which stock market booms and busts arise and end. We find mixed evidence about the role of output shocks on the market but that inflation and interest rate shocks universally had a negative and significant impact on market conditions.[20] Thus, the policy lesson we draw concerns not necessarily what policymakers ought to do when faced with a bubbling stock market but how they can contribute to equity market stability by minimizing unanticipated fluctuations in inflation. Similarly, the impulse responses to long-term interest rate shocks suggest that monetary policies that induce financial markets to reduce inflation risk premia in long-term interest rates will promote equity market stability.

Methodologically, sampling the latent boom/bust stock market conditions variable in the hybrid Qual-VAR model allows us to examine quantitatively the determinants and

[20] Whereas inflation shocks appear to have a large impact on stock market conditions, we find no support for the view that stock market booms and busts affect inflation. Although many booms ended following an increase in inflation and subsequent policy tightening, we find no evidence that the booms themselves caused inflation to rise (or that stock market busts caused disinflation).

consequences of stock market booms and busts. The use of a latent boom/bust measure of stock market conditions captures an additional channel through which a central bank's efforts to reduce fluctuations in inflation can contribute to greater asset market stability and reduced variance of stock prices.

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Appendix

This appendix provides information about the data and sources used in this paper.

Stock Price Index:

Germany: CDAX Composite Index. Source: Global Financial Data (www.globalfinancialdata.com) (series FWBXXM).

United Kingdom: FT-Actuaries All-Share Index. Source: Global Financial Data (series FTASM).

United States: Standard and Poor's 500 Composite Index (1941-1943=10), monthly average of daily data. Source: Haver Analytics.

Consumer Price Level:

Germany: Consumer Price Index. Source: Global Financial Data (series CPDEUM).

United Kingdom: Retail Price Index. Source: Global Financial Data (series CPGBRM).

United States: All Items Consumer Price Index for urban consumers (not seasonally adjusted, 1982-84=100). Source: Haver Analytics.

Output:

Germany: Real GDP (1919-39). Source: Maddison (2003), Table 1b. Index of Industrial Production(seasonally adjusted, 2000=100) (1958-2005). Source: Haver Analytics.

United Kingdom: *Economist* Index of Business Activity (seasonally adjusted, 1924=100) (1924-38). Source: Capie and Collins (1983), Table 3.1. Index of Industrial Production (not seasonally adjusted, 2000=100). Source: Haver Analytics (seasonally adjusted by the authors).

United States: Index of Industrial Production (seasonally adjusted, 2002=100). Source: Haver Analytics.

Money Stock:

Germany: Bundesbank M2 (seasonally adjusted). Source: Global Insight (www.globalinsight.com).

United Kingdom: Bank of England M4 (seasonally adjusted). Source: Bank of England.

United States: Broad money stock (1920-58). Source: Friedman and Schwartz (1963), Table A-1, column 8. Board of Governors M2 (1959-2005). Source: Federal Reserve Bank of St. Louis.

Long-term Treasury Yield:

Germany: Yield on 10-year government bond. Source: Global Insight.

United Kingdom: Yield on 5-year government note. Source: Global Financial Data (series IGGBR5D).

United States: Yield on 10-year constant maturity Treasury security. Source: Haver Analytics.

Short-term Interest Rate:

Germany: Yield on 3-month Treasury bill. Source: Global Insight.

United Kingdom: Yield on 3-month Treasury bill. Source: Global Financial Data (series ITGBR3D).

United States: Yield on 4-6 month commercial paper (1920-39). Source: Board of Governors of the Federal Reserve System (1943). Secondary market (discount) yield on 3-month Treasury bills (1953-2005). Source: Haver Analytics.

Table 1

Stock Market Booms and Busts

Country	Boom Start: Local Market Minimum	Boom End: Local Market Peak	Avg. Annual % Change from month after trough to peak	Bust Start: Local Market Peak	Bust End: Local Market Trough	Avg. Annual % Change from month after peak to trough
Germany	June 1957	Sept. 1960	43.6	Sept. 1960	Oct. 1962	-31.3
	Jan. 1967	Nov. 1969	19.8	Sept. 1964	Jan. 1967	-21.3
	Aug. 1982	Apr. 1986	31.8	Nov. 1969	Oct. 1971	-20.8
	Jan. 1988	Mar. 1990	32.0	July 1972	Oct. 1974	-21.8
	Mar. 1995	Feb. 2000	23.9	Aug. 1987	Jan. 1988	-110.1
				Feb. 2000	Mar. 2003	-35.0
United Kingdom	June 1952	July 1955	20.0	May 1951	June 1952	-35.9
	Feb. 1958	Apr. 1961	25.4	Apr. 1961	July 1962	-28.4
	Oct. 1966	Dec. 1968	27.2	Dec. 1968	May 1970	-30.2
	May 1970	Apr. 1972	21.7	Apr. 1972	Dec. 1974	-53.5
	Sept. 1981	July 1987	21.3	Apr. 1979	May 1980	-29.6
	June 1994	Dec. 1999	12.6	July 1987	Nov. 1987	-112.3
				Aug. 1989	Sept. 1990	-28.6
				Dec. 1999	Mar. 2003	-19.9
United States	Sept. 1953	Apr. 1956	28.8	Dec. 1961	June 1962	-49.8
	June 1962	Jan. 1966	13.3	Jan. 1966	Oct. 1966	-29.2
	July 1984	Aug. 1987	22.9	Dec. 1968	July 1970	-26.5
	Apr. 1994	Aug. 2000	17.1	Jan. 1973	Dec. 1974	-38.3
				Nov. 1980	July 1982	-19.9
				Aug. 1987	Dec. 1987	-91.0
				Aug. 2000	Feb. 2003	-23.7

Figure 1: US Real Stock Price and Consumer Price Index, 1919-39

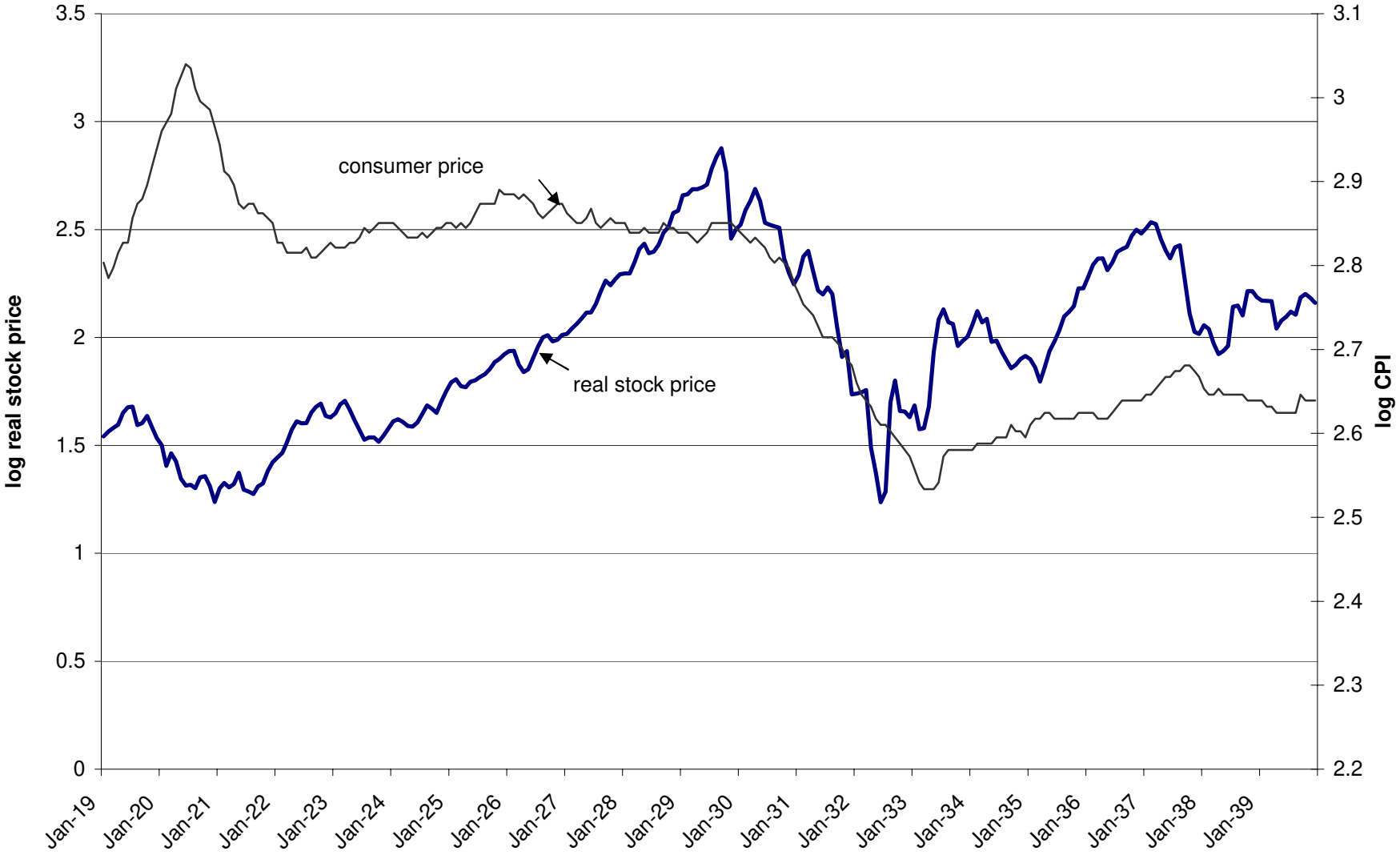

Figure 2: UK Real Stock Price and Retail Price Level, 1919-39

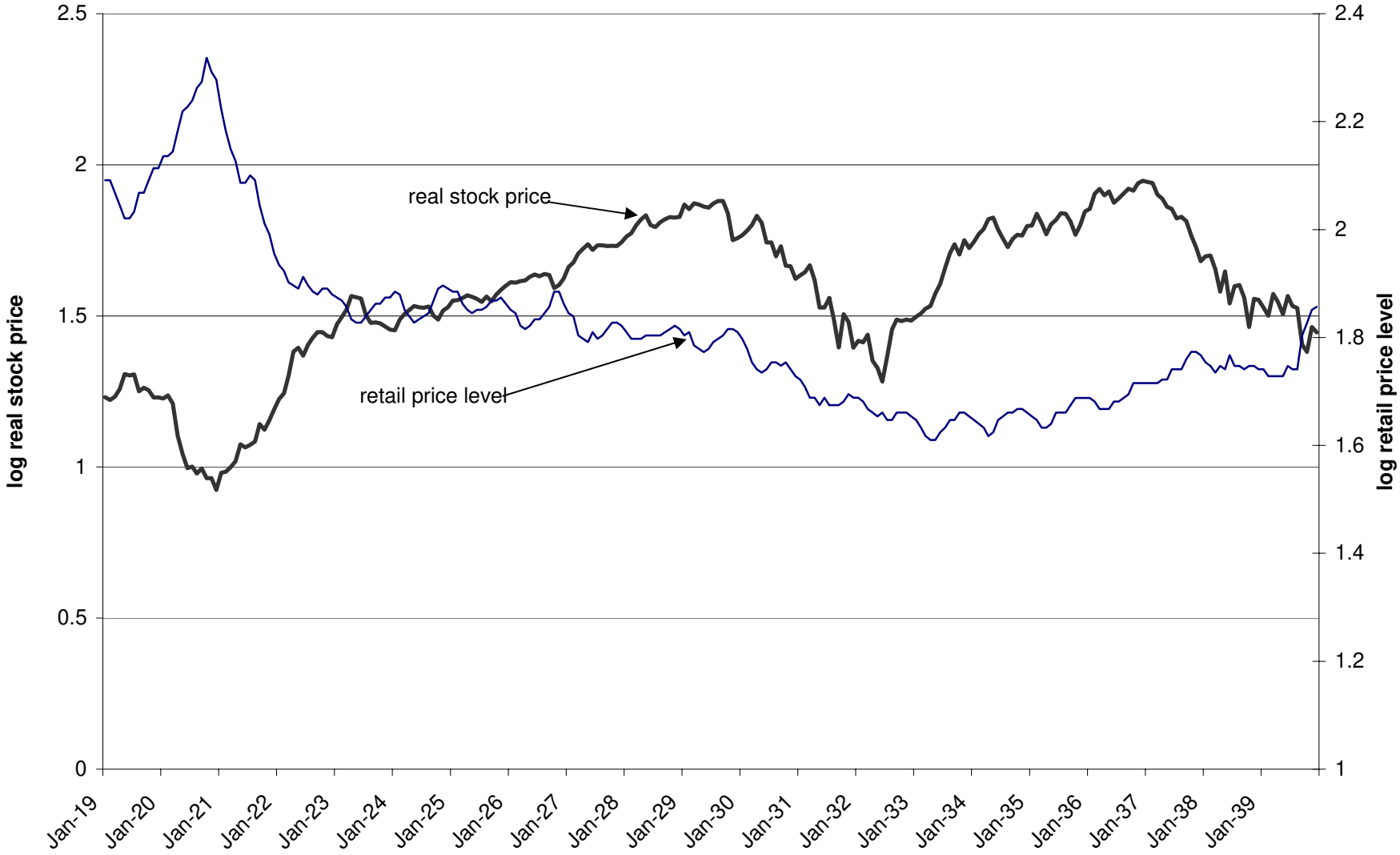

Figure 3: US Real Stock Price and Industrial Production, 1919-39

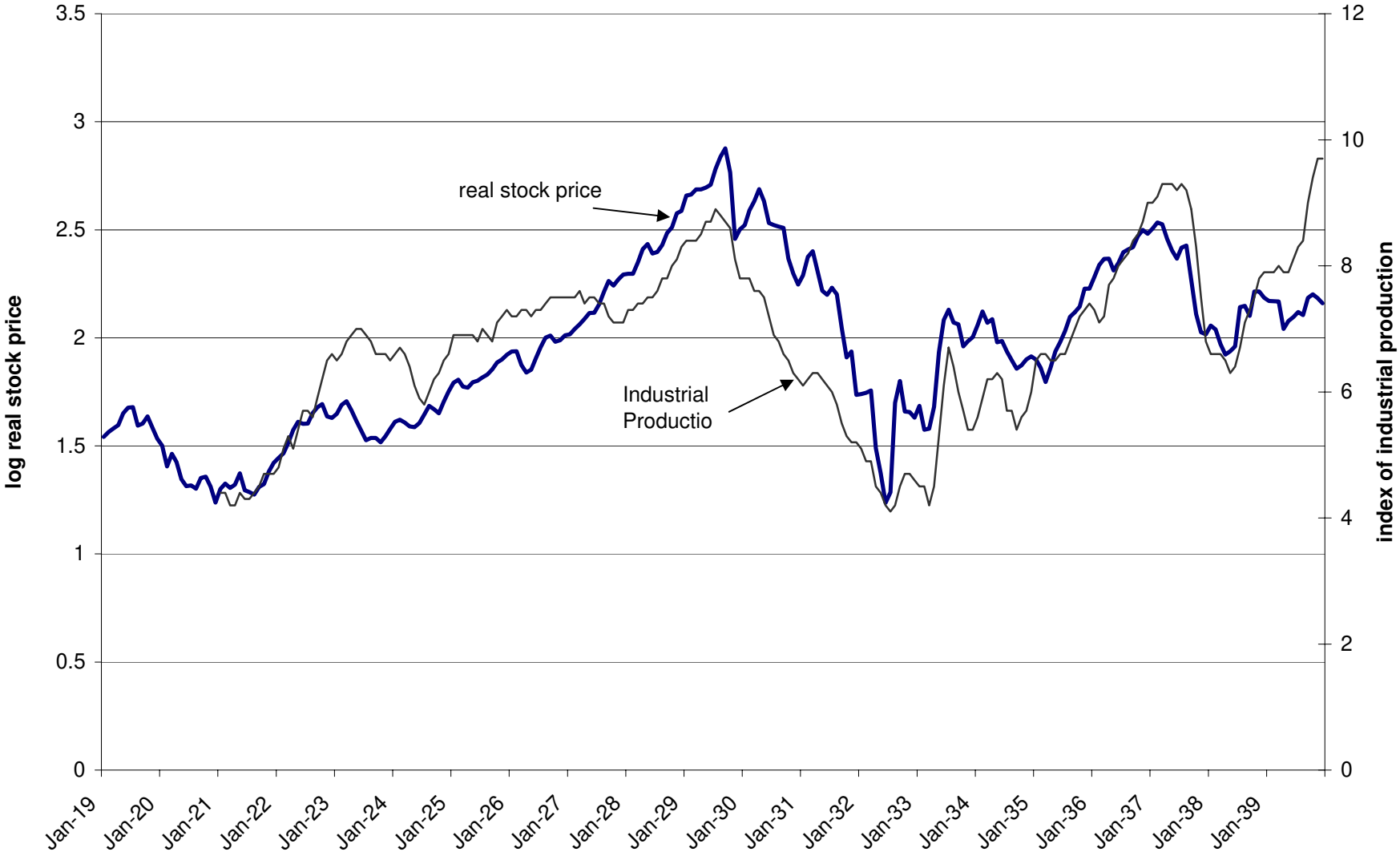

Figure 4: UK Real Stock Price and Economic Activity, 1919-39

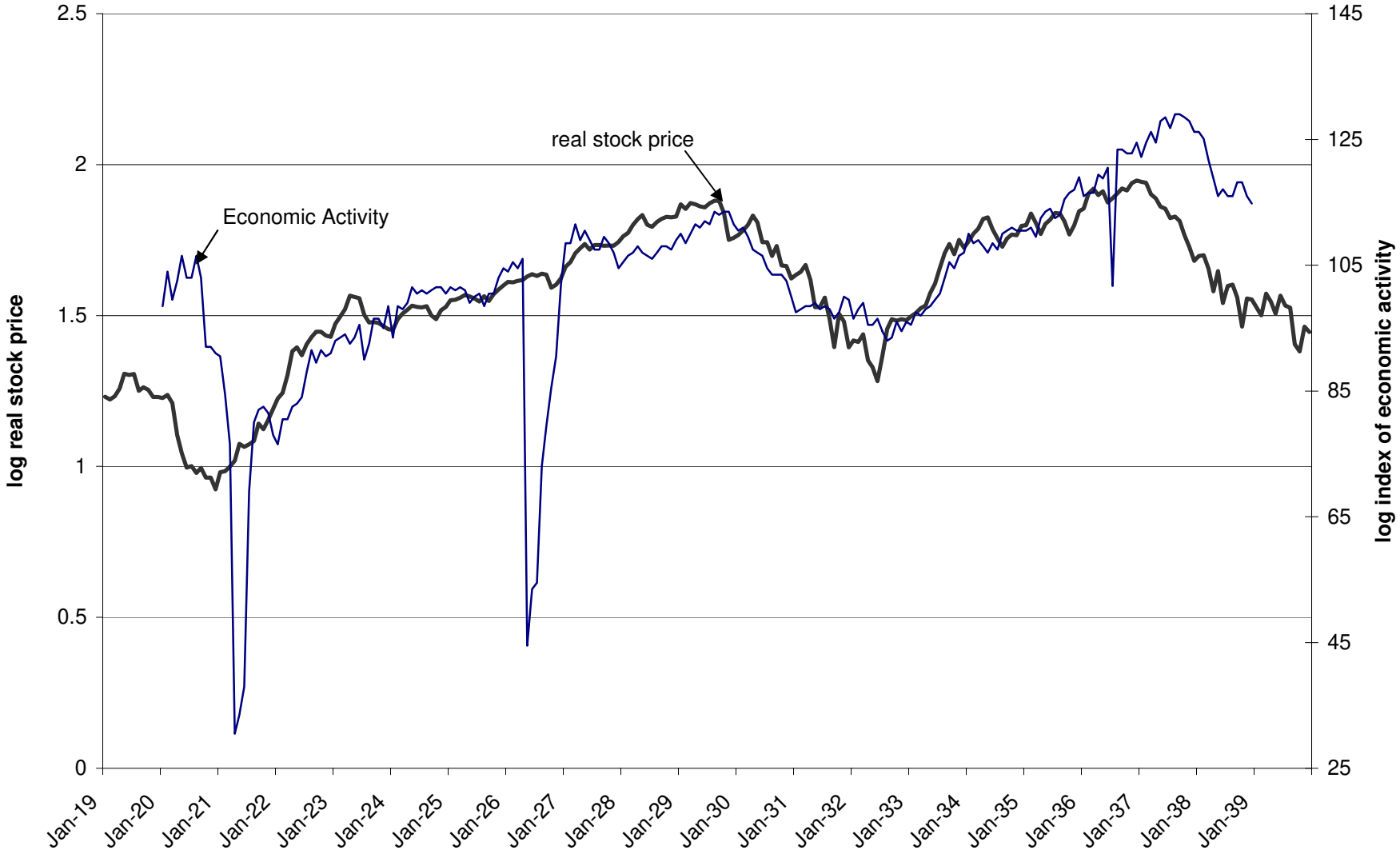

Figure 5: Germany Real Stock Price, Real GDP, and Consumer Price Level, 1924-39

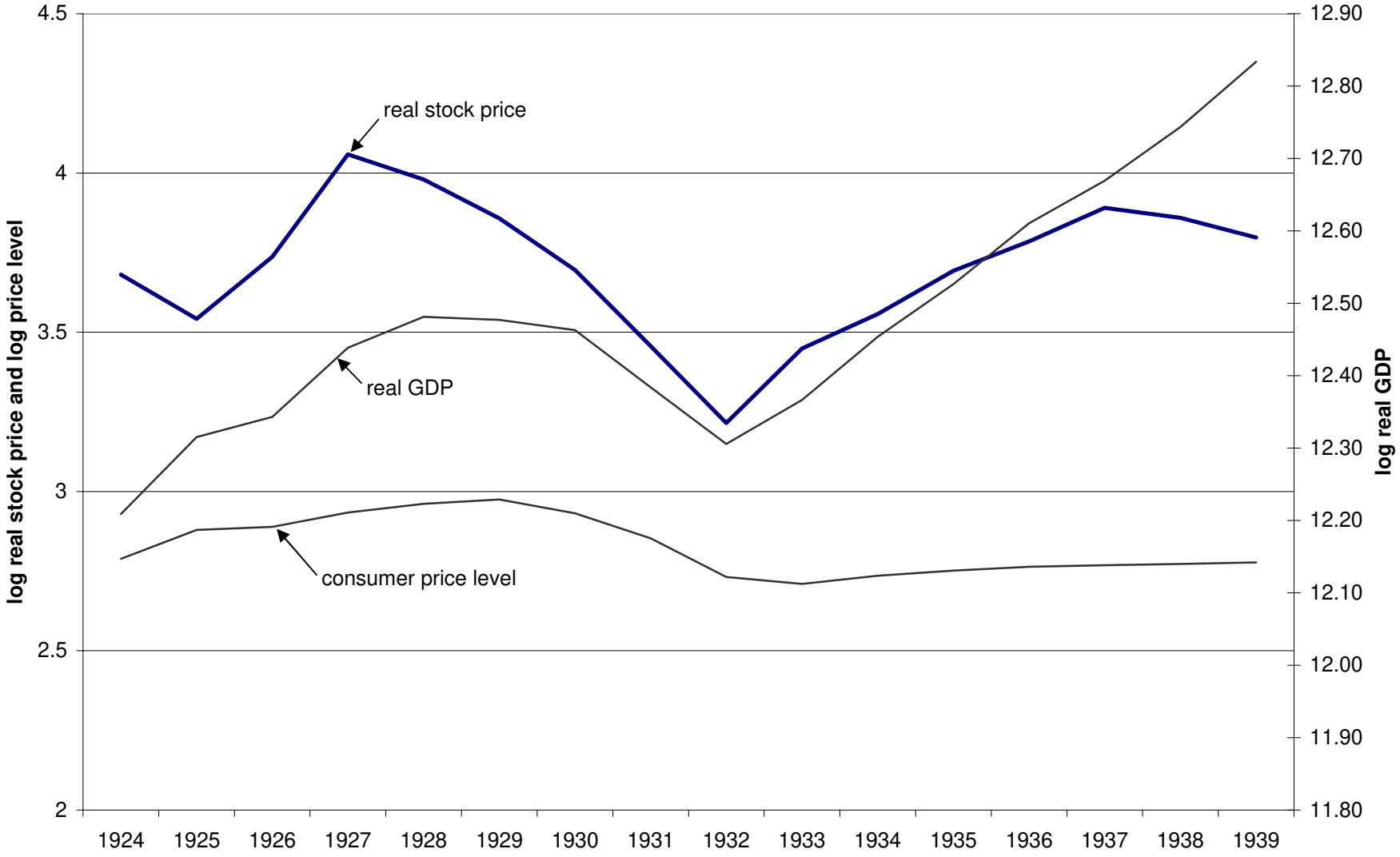

Figure 6: US Real Stock Price and Money Stock, 1919-39

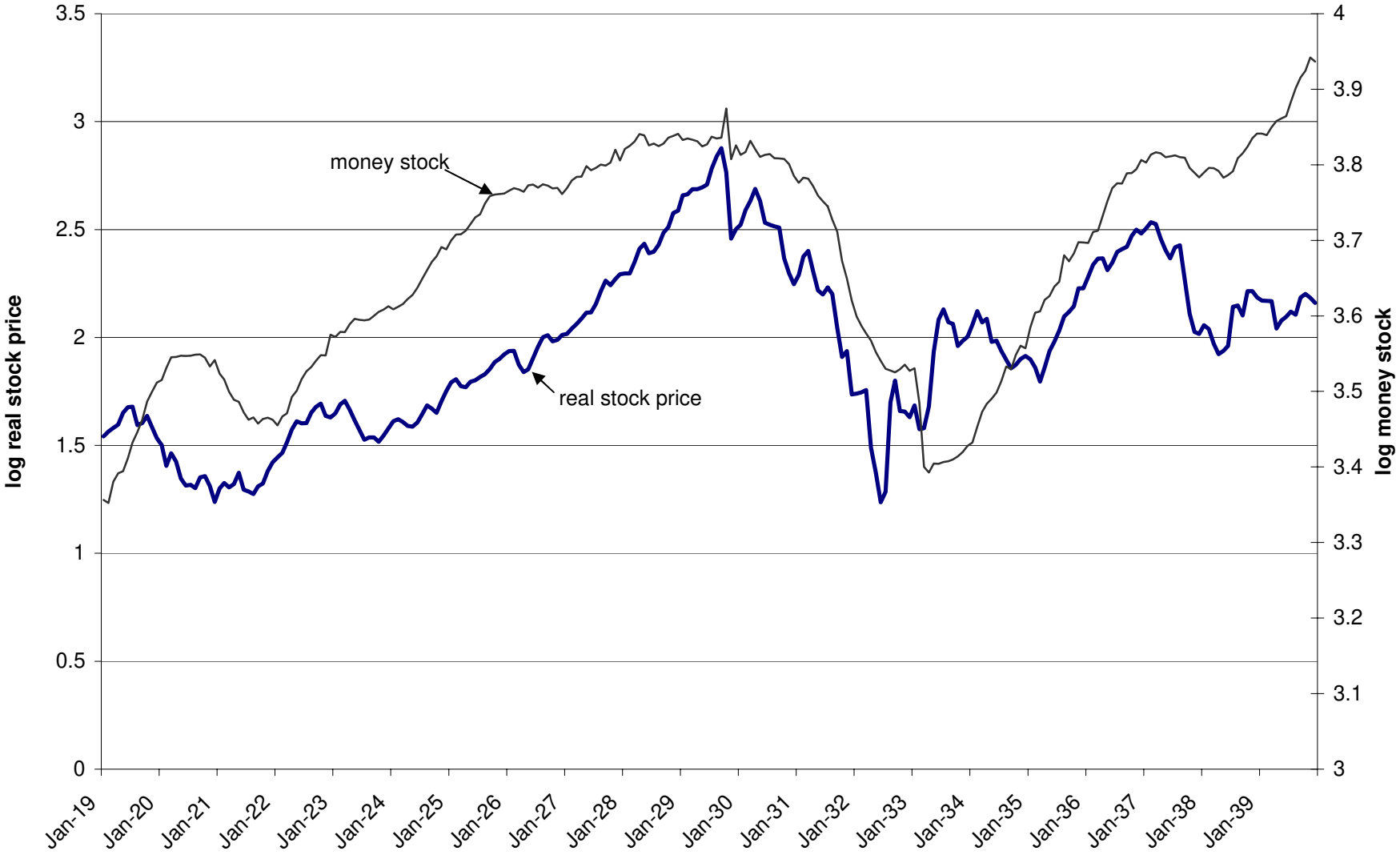

Figure 7: US Real Stock Price and Commercial Paper Interest Rate, 1919-39

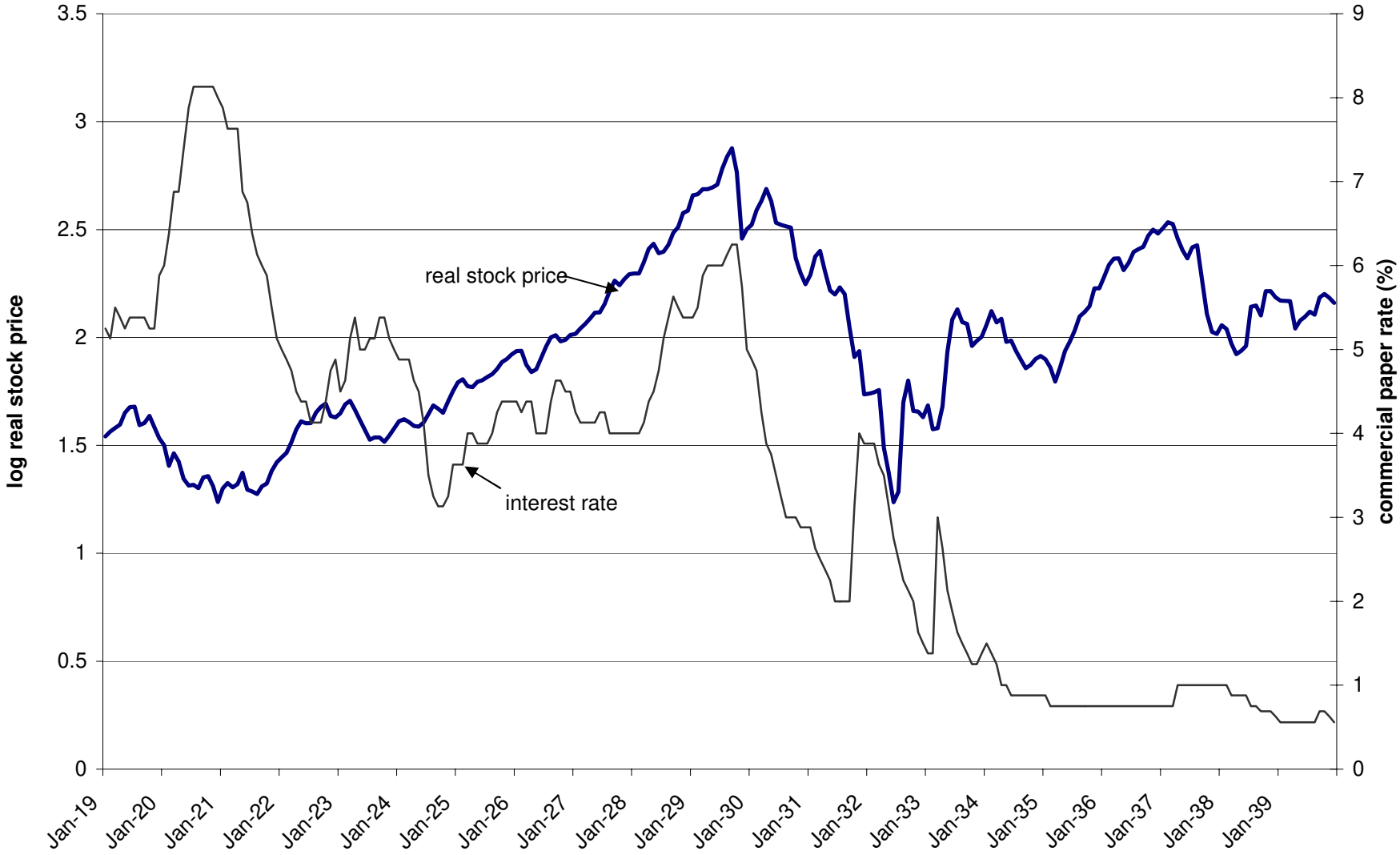

Figure 8: Real Stock Price Indexes, 1948-2004

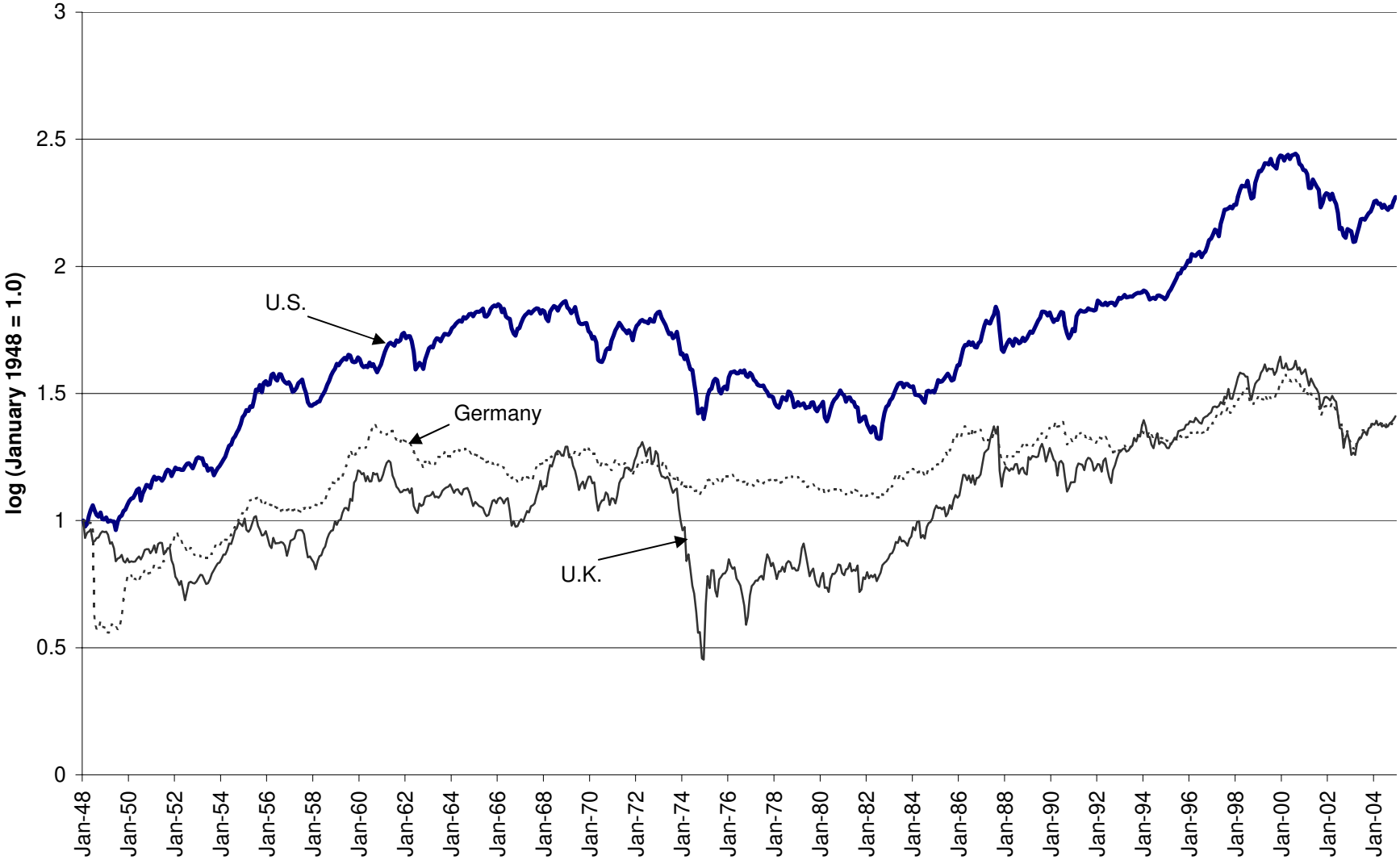

Figure 9: Consumer Price Indexes, 1948-2004

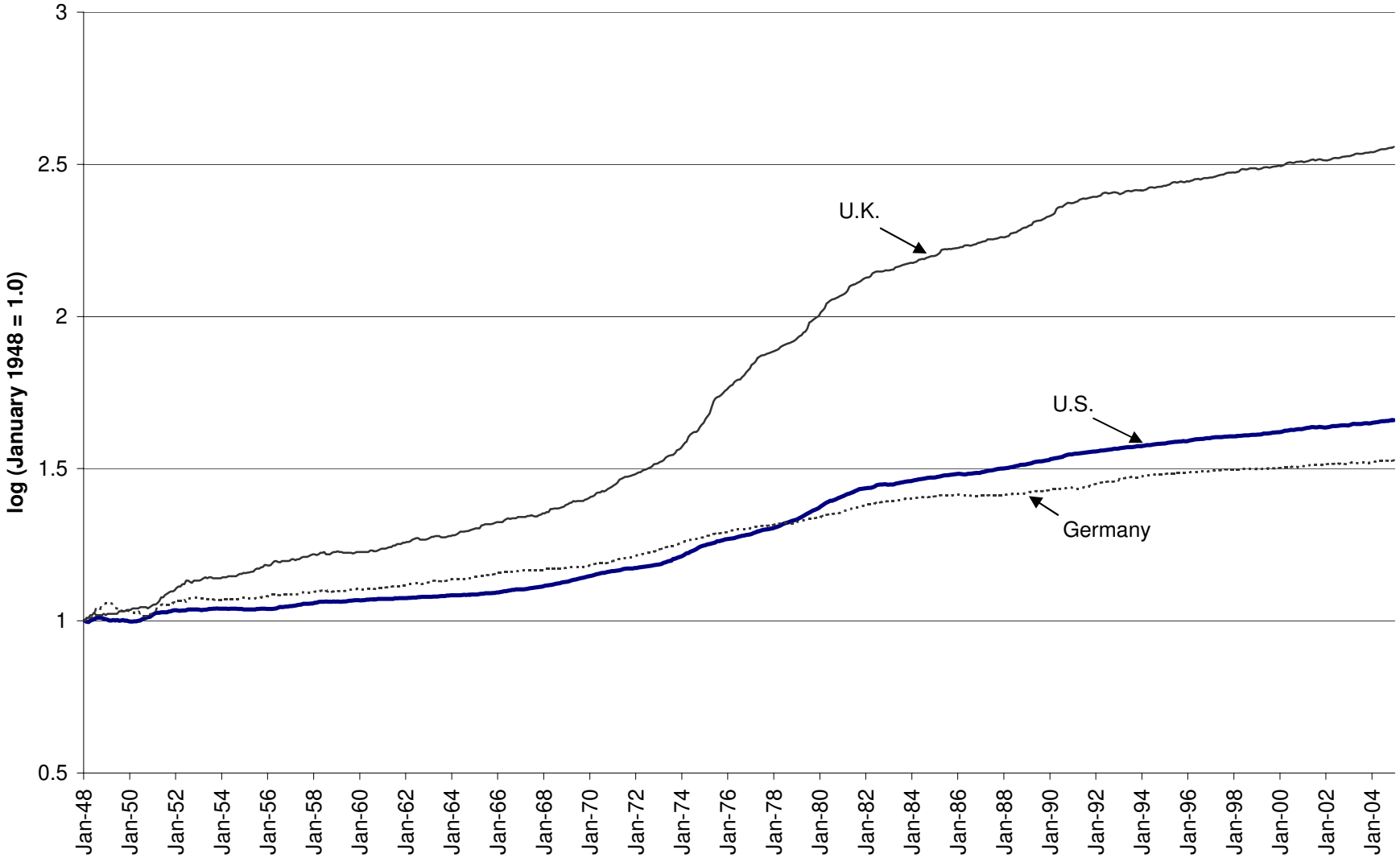

Figure 10: United States Boom Category Model-implied Draws of the Latent Variable

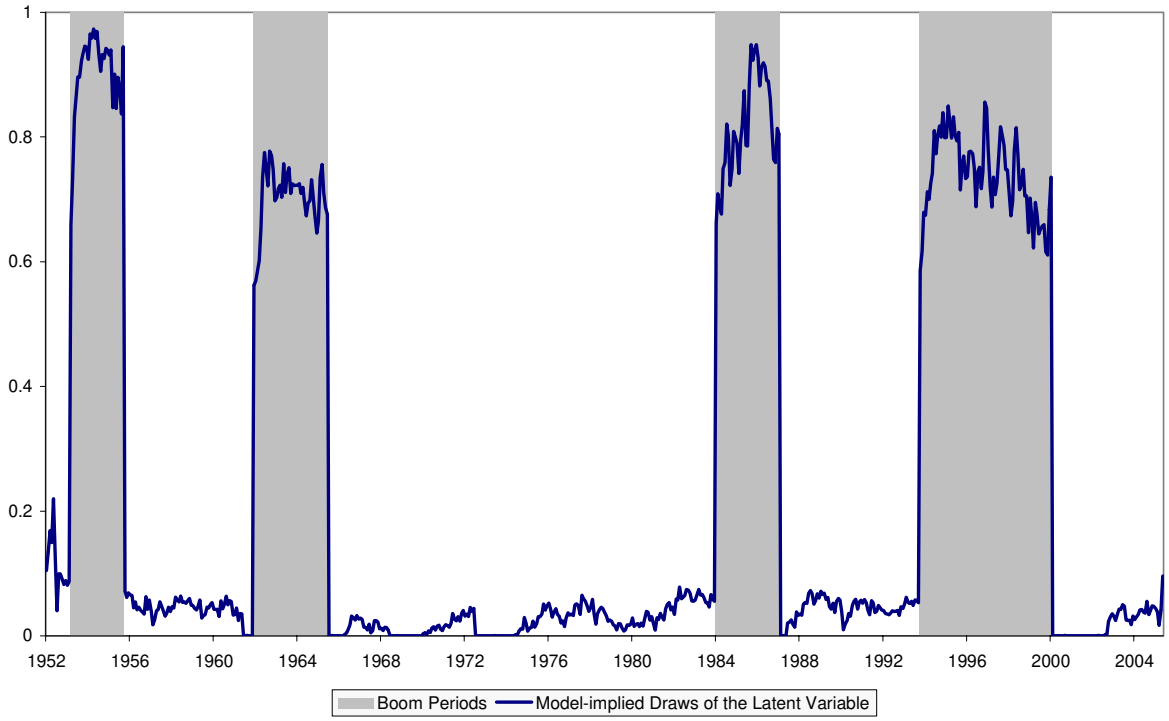

Figure 11: United States Bust Category Model-implied Draws of the Latent Variable

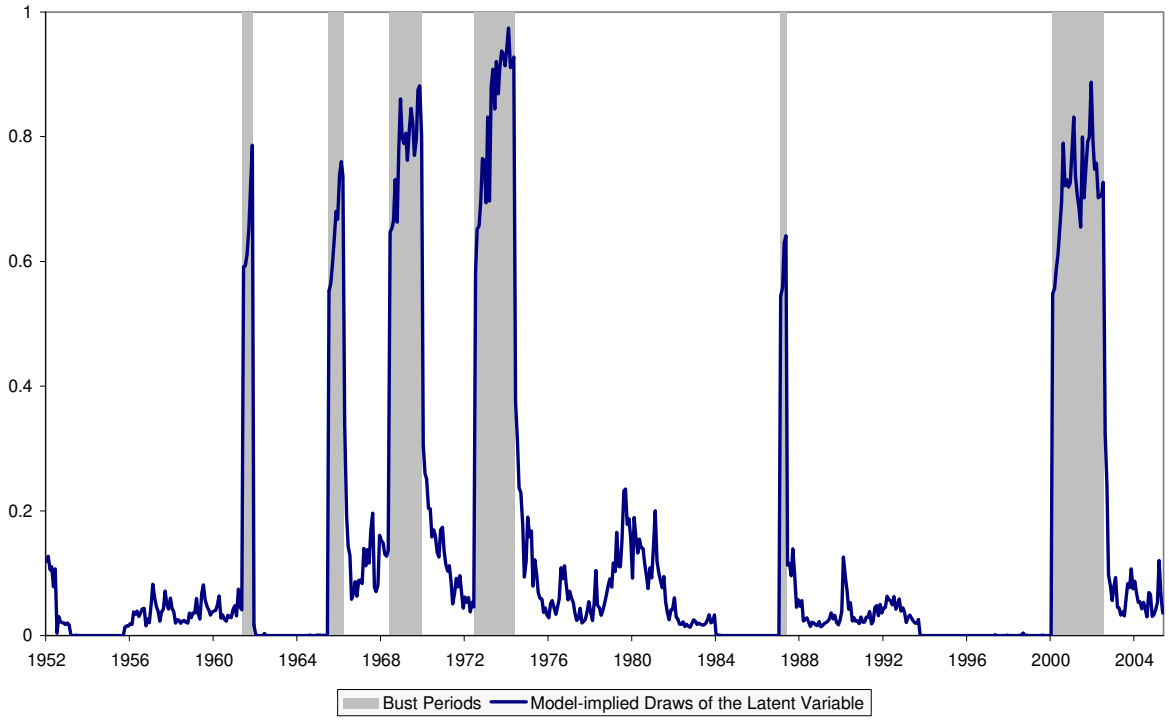

Figure 12: United States Normal Category Model-implied Draws of the Latent Variable

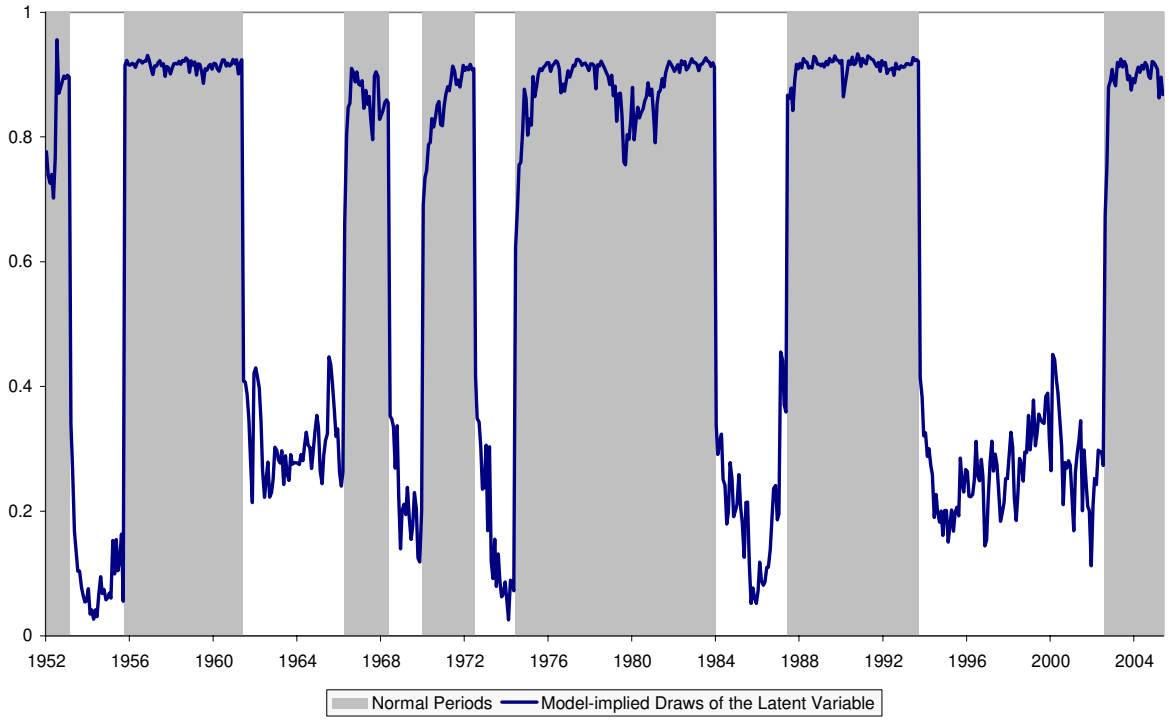

Figure 13: Impulse Response Functions of Stock Market Variables for the United States

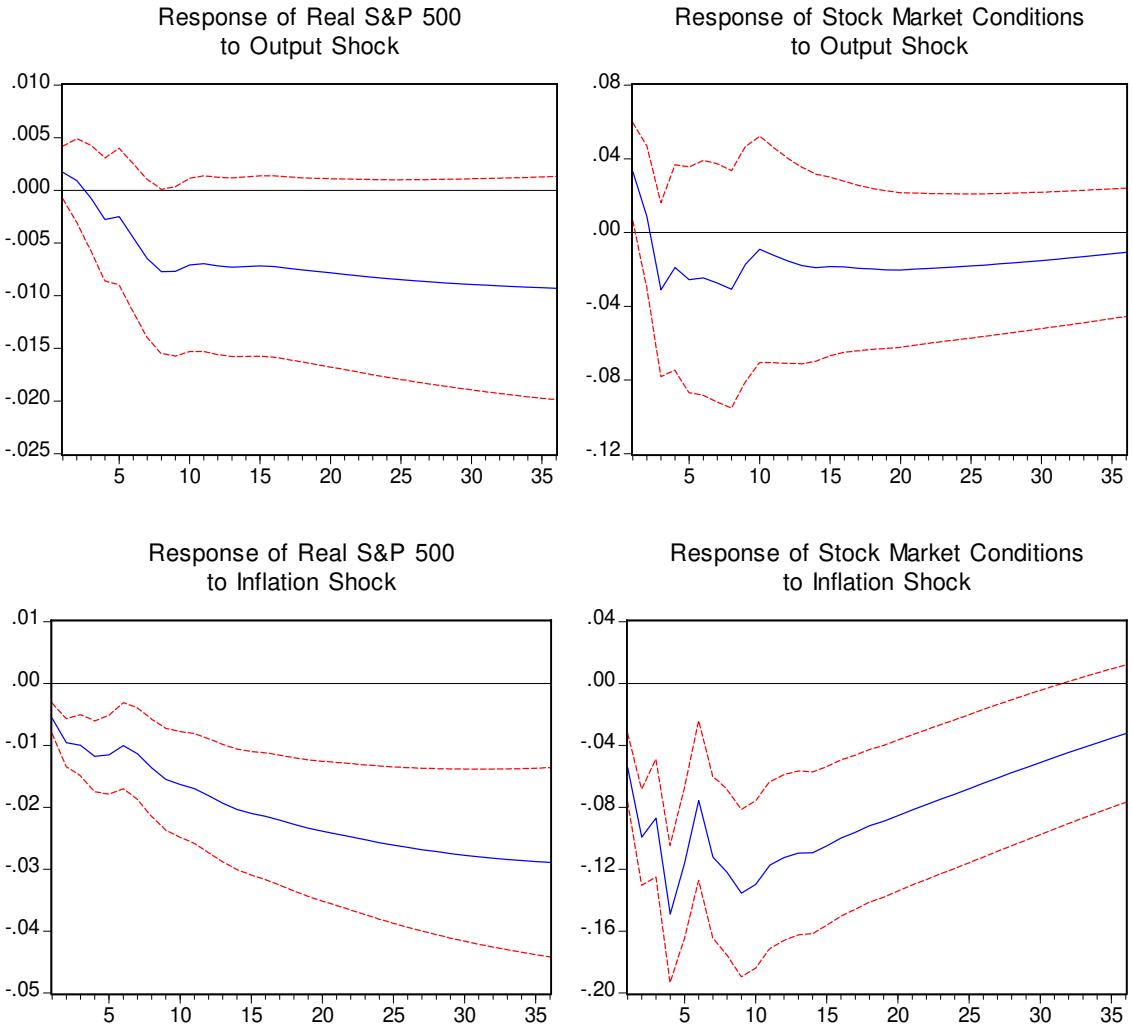

Figure 14: Impulse Response Functions of Stock Market Variables for the United States

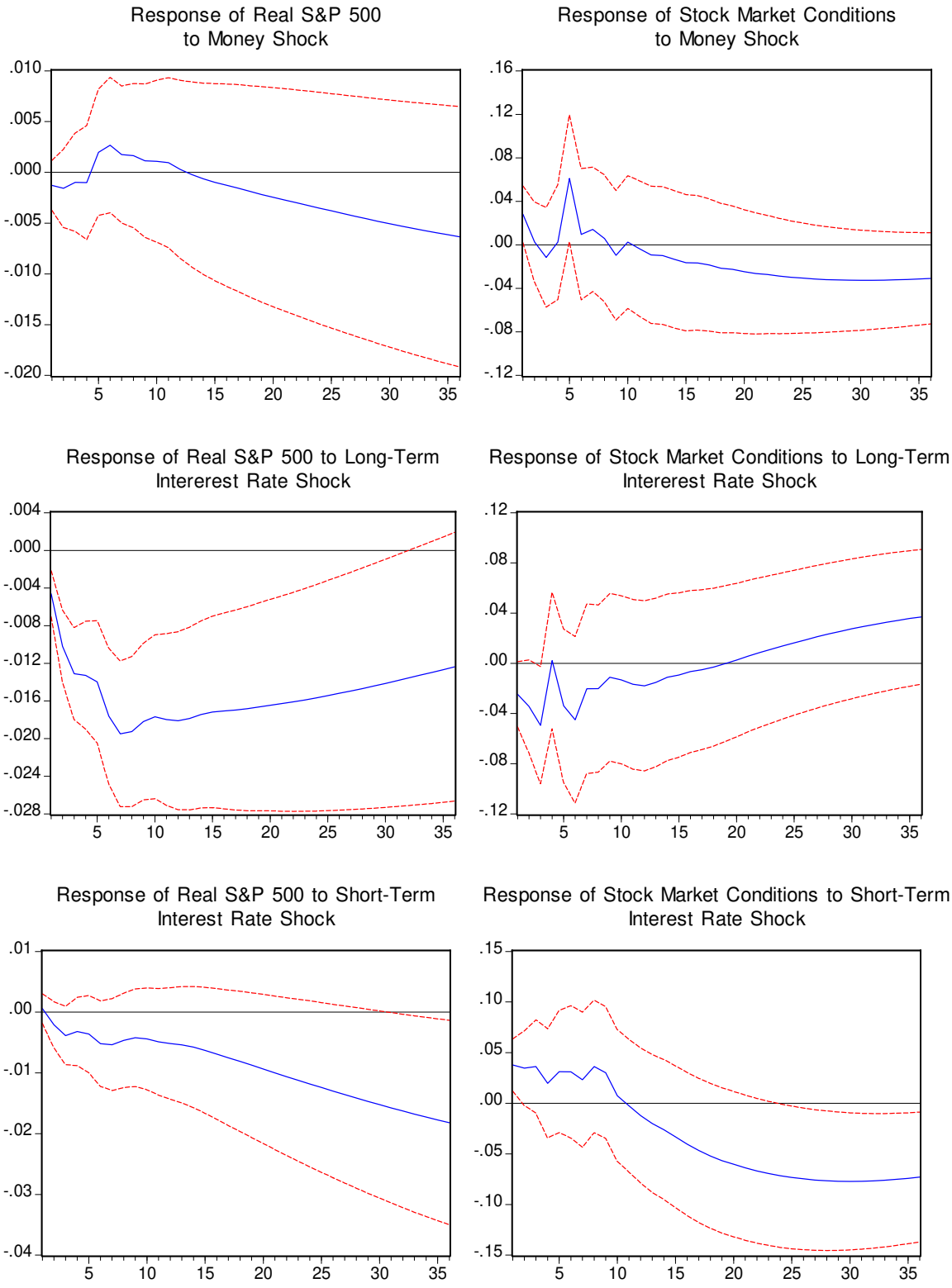

Figure 15: United States Counterfactual Simulations - Stock Market Conditions Without Output Shock

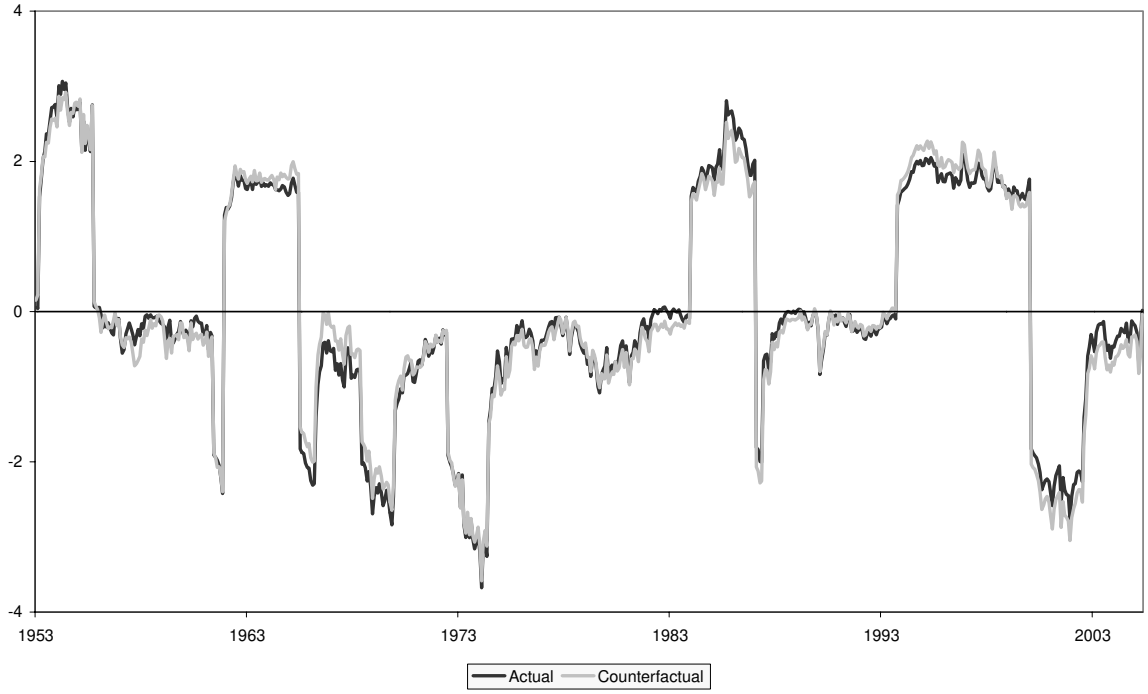

Figure 16: United States Counterfactual Simulations - Stock Market Conditions Without Inflation Shock

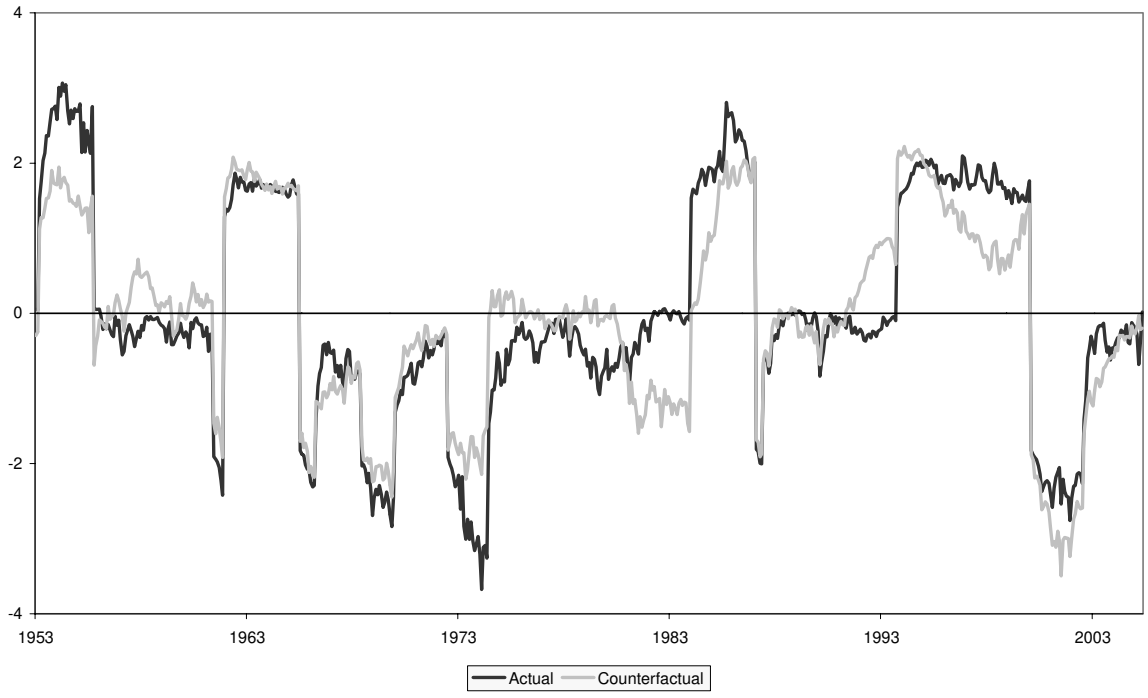

Figure 17: United States Counterfactual Simulations - Stock Market Conditions Without Long Rate Shock

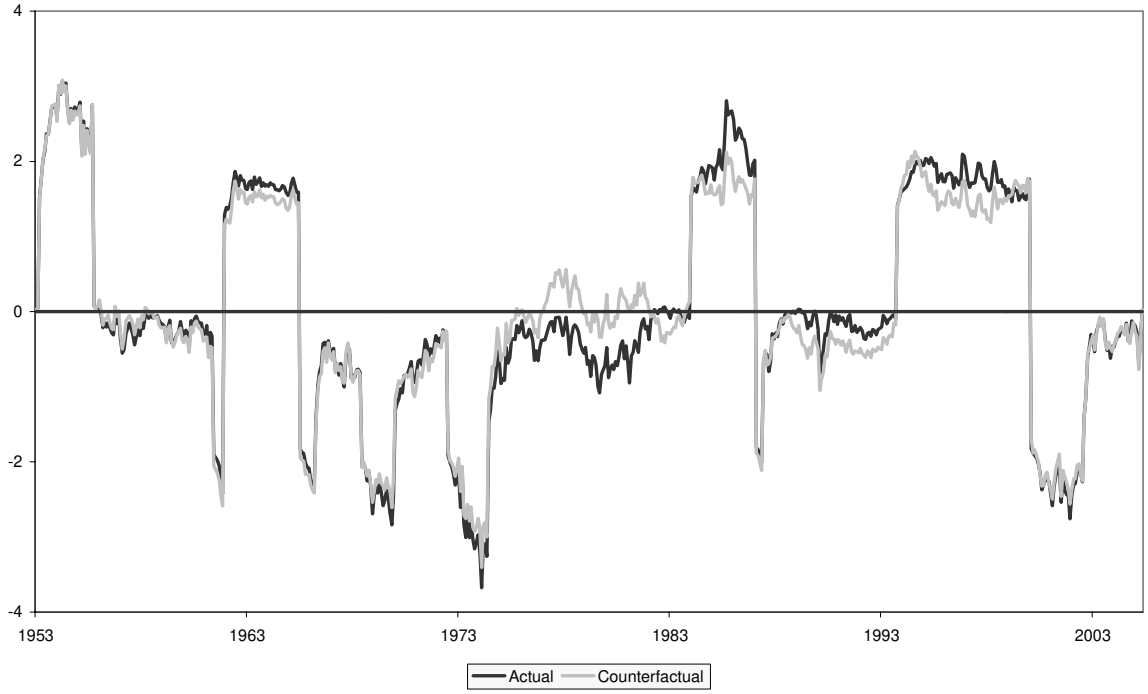

Figure 18: Impulse Response Functions of Stock Market Variables for the United Kingdom

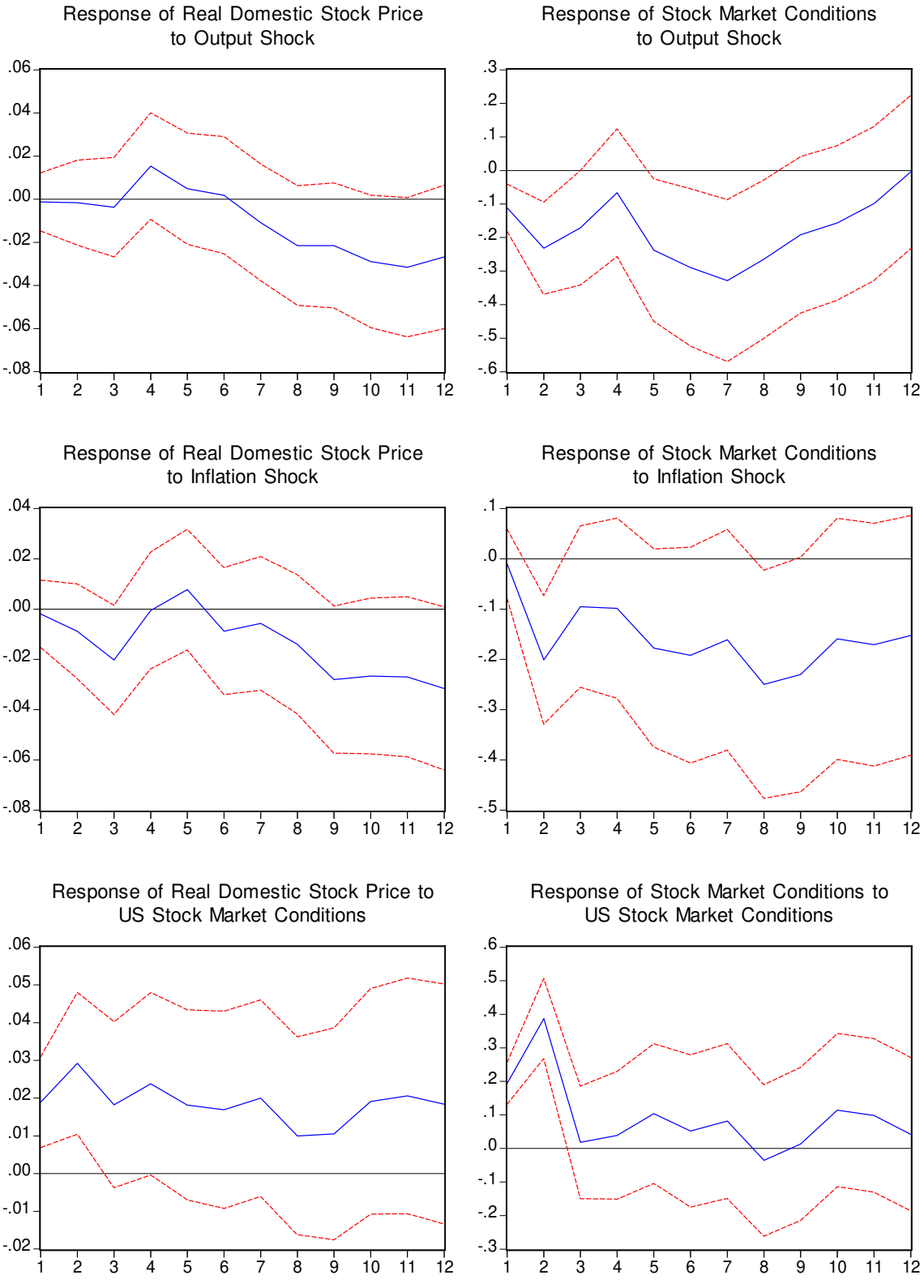

Figure 19: Impulse Response Functions of Stock Market Variables for the United Kingdom

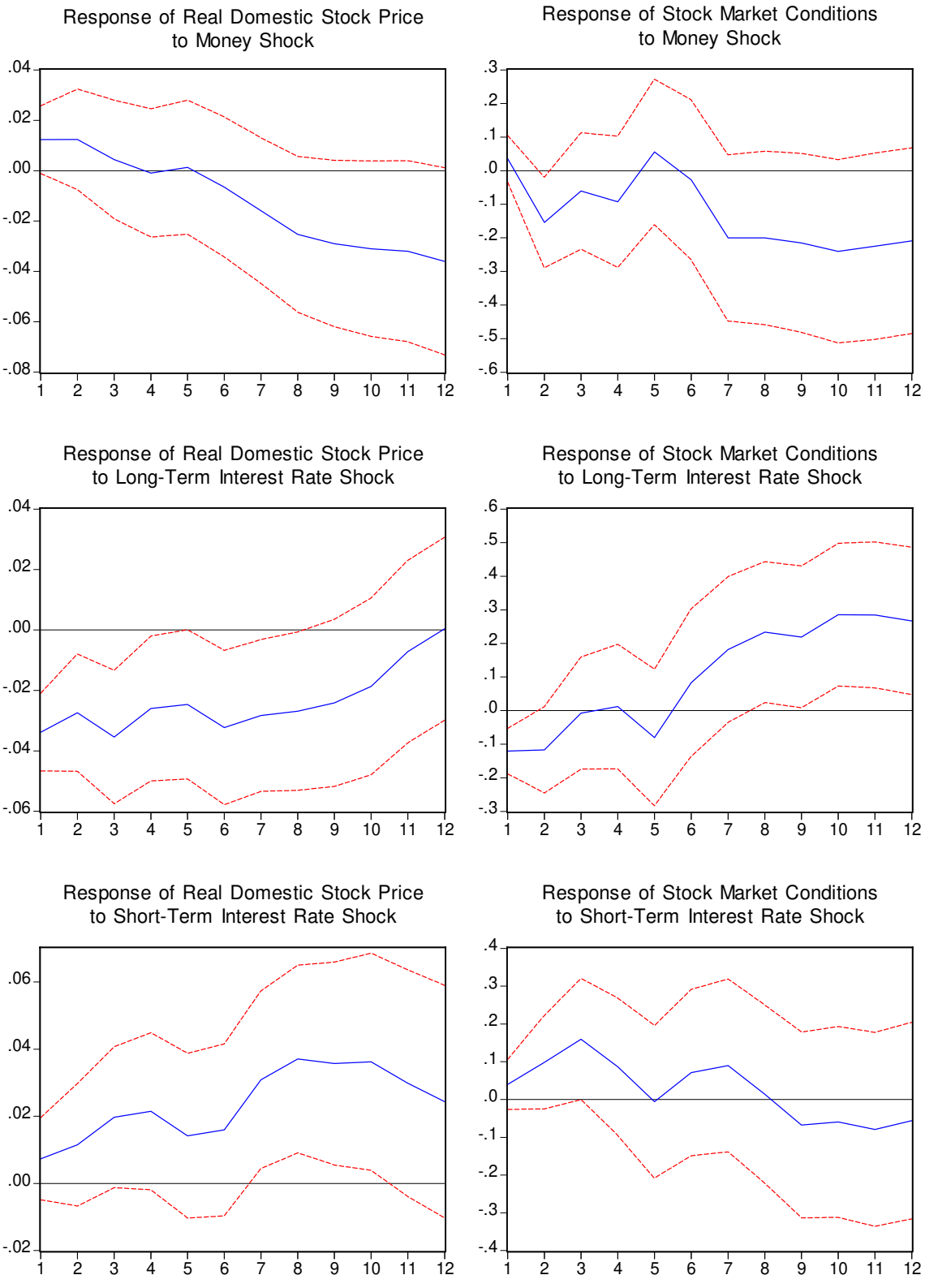

Figure 20: United Kingdom Counterfactual Simulations - Stock Market Conditions Without Output Shock

Figure 21: United Kingdom Counterfactual Simulations - Stock Market Conditions Without Inflation Shock

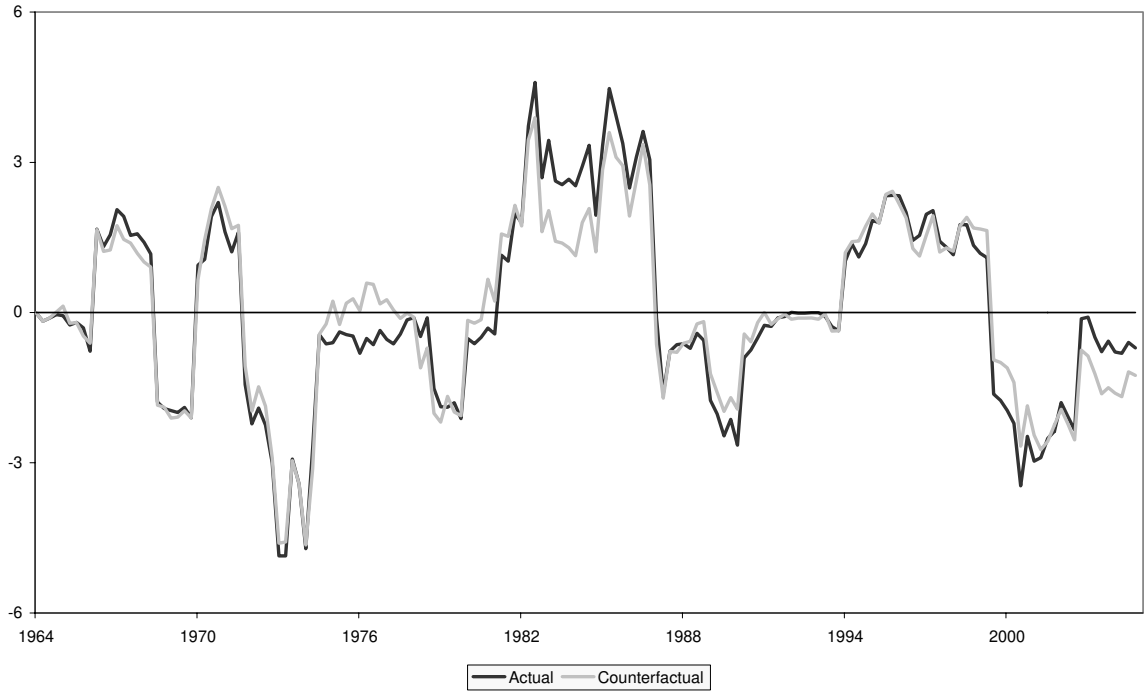

Figure 22: United Kingdom Counterfactual Simulations - Stock Market Conditions Without Long Rate Shock

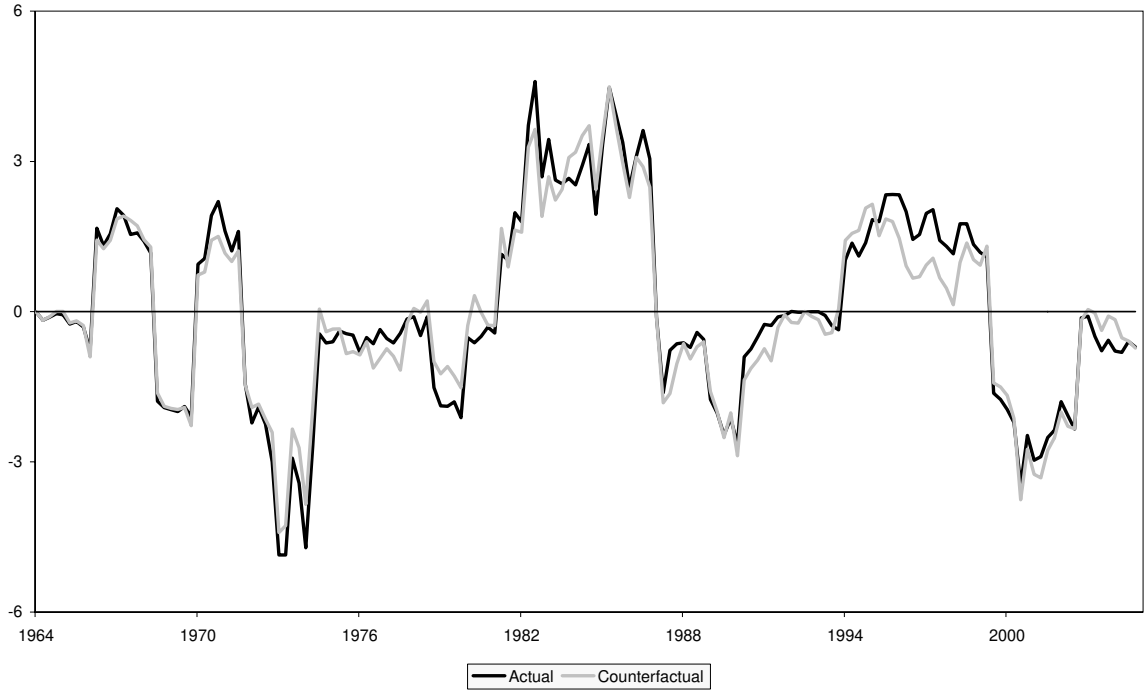

Figure 23: United Kingdom Counterfactual Simulations - Stock Market Conditions Without US Stock Market Conditions Shock

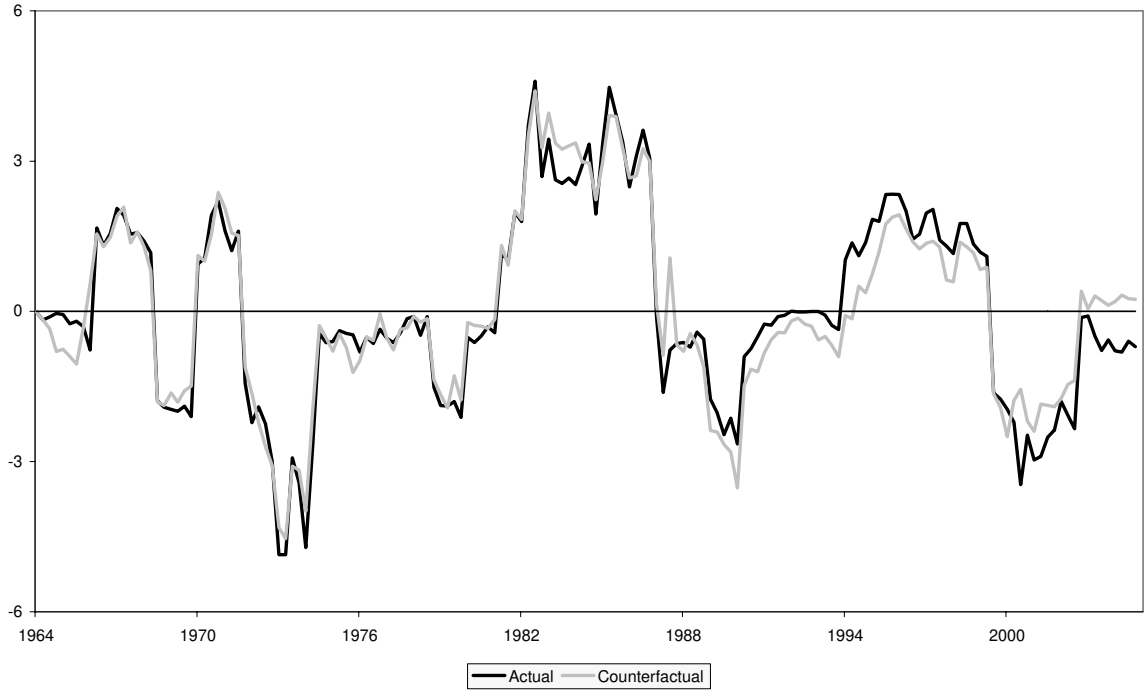

Figure 24: Impulse Response Functions of Stock Market Variables for Germany

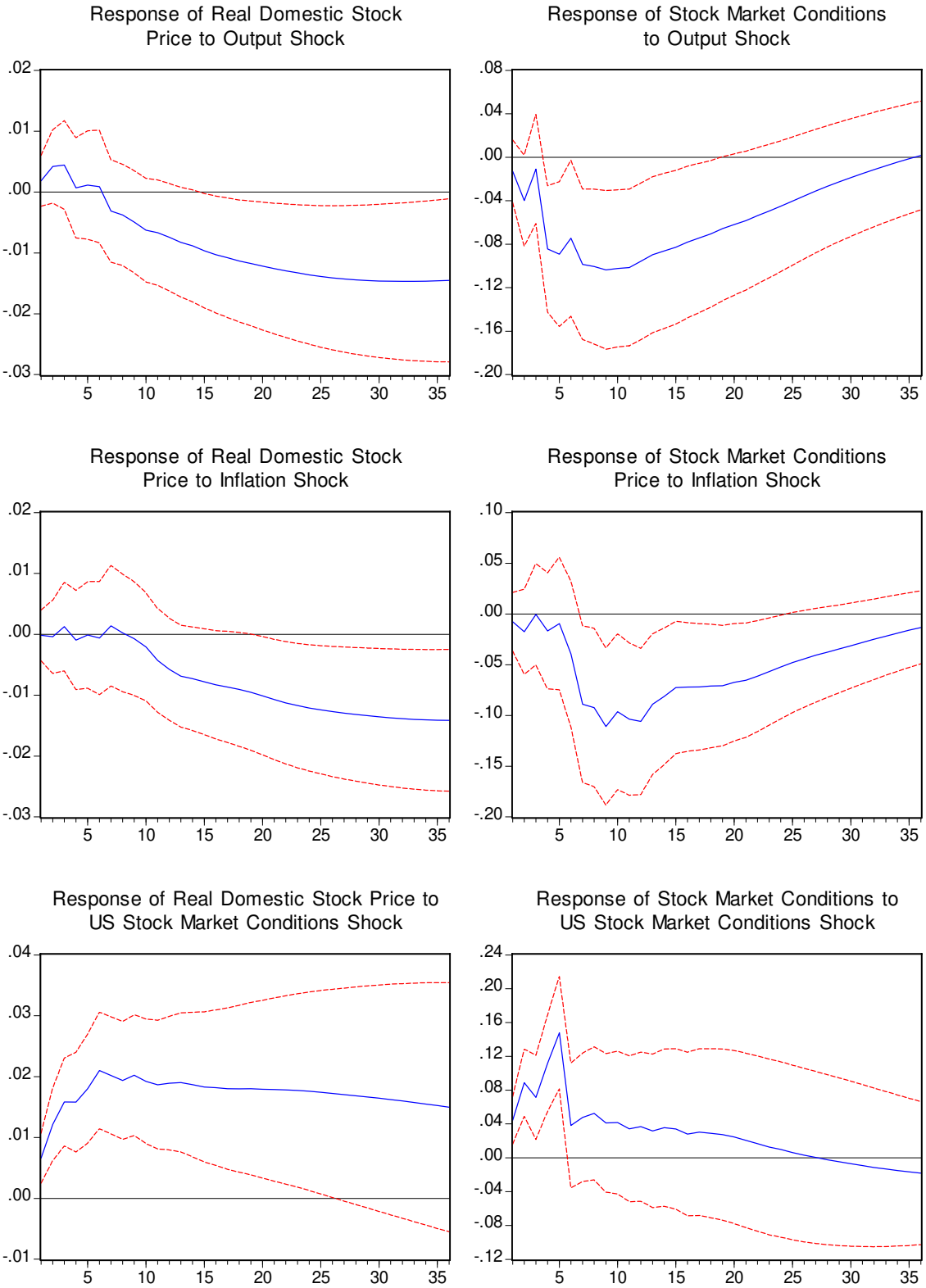

Figure 25: Impulse Response Functions of Stock Market Variables for Germany

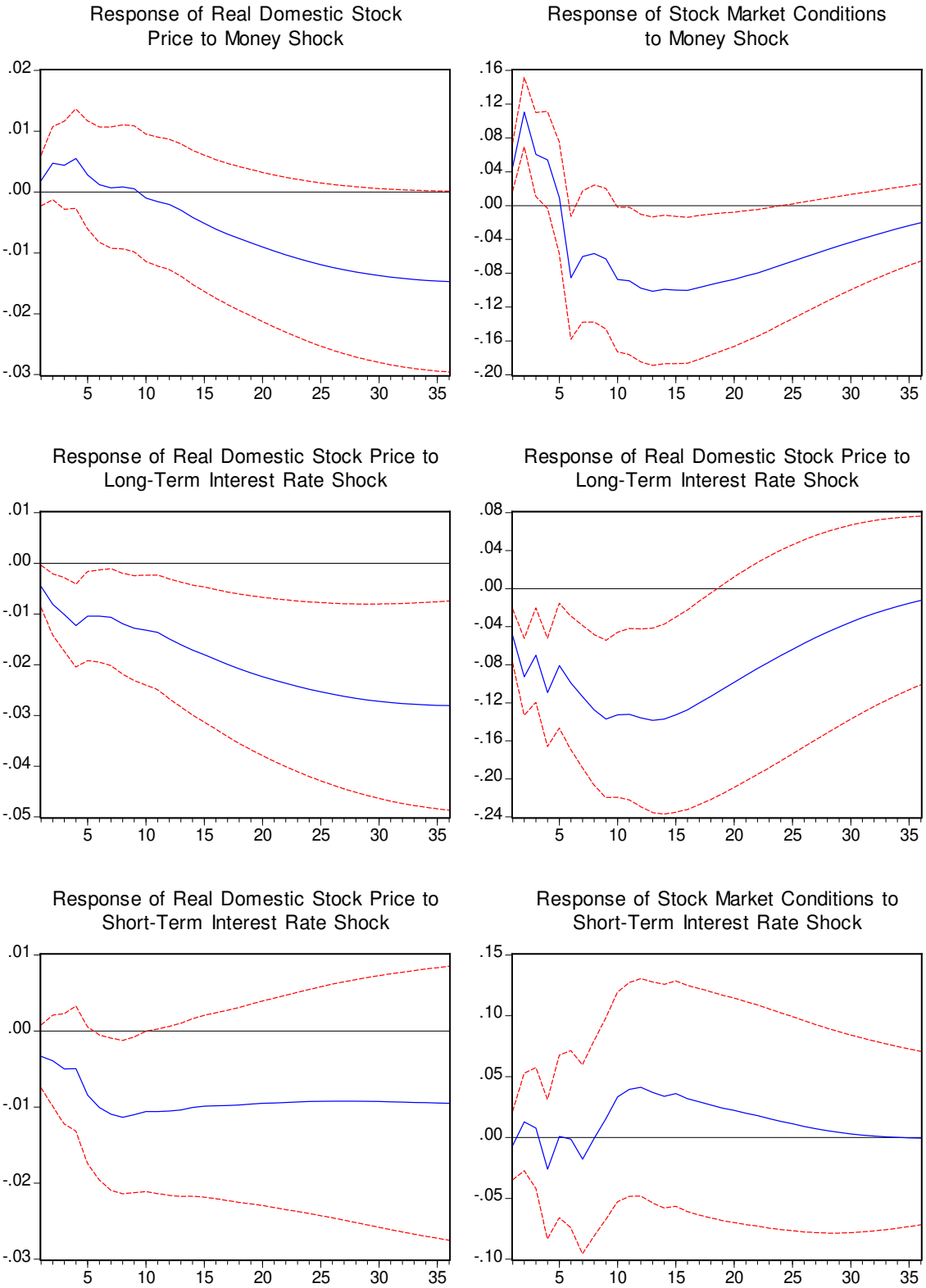

Figure 26: Germany Counterfactual Simulations - Stock Market Conditions Without Output Shock

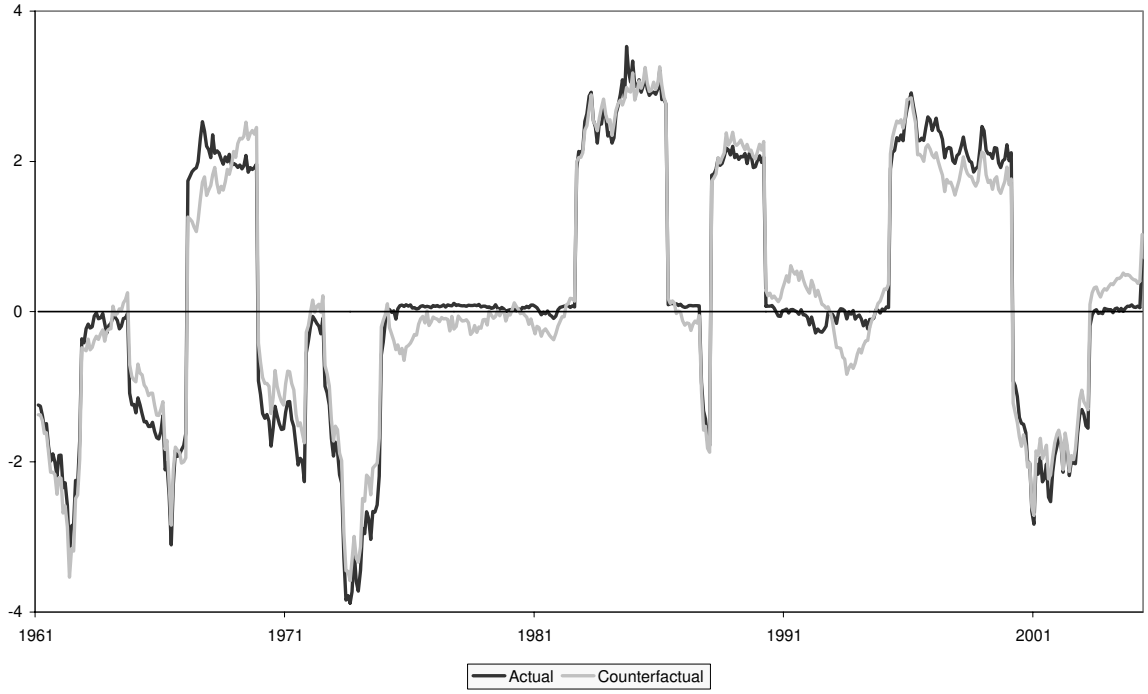

Figure 27: Germany Counterfactual Simulations - Stock Market Conditions Without Inflation Shock

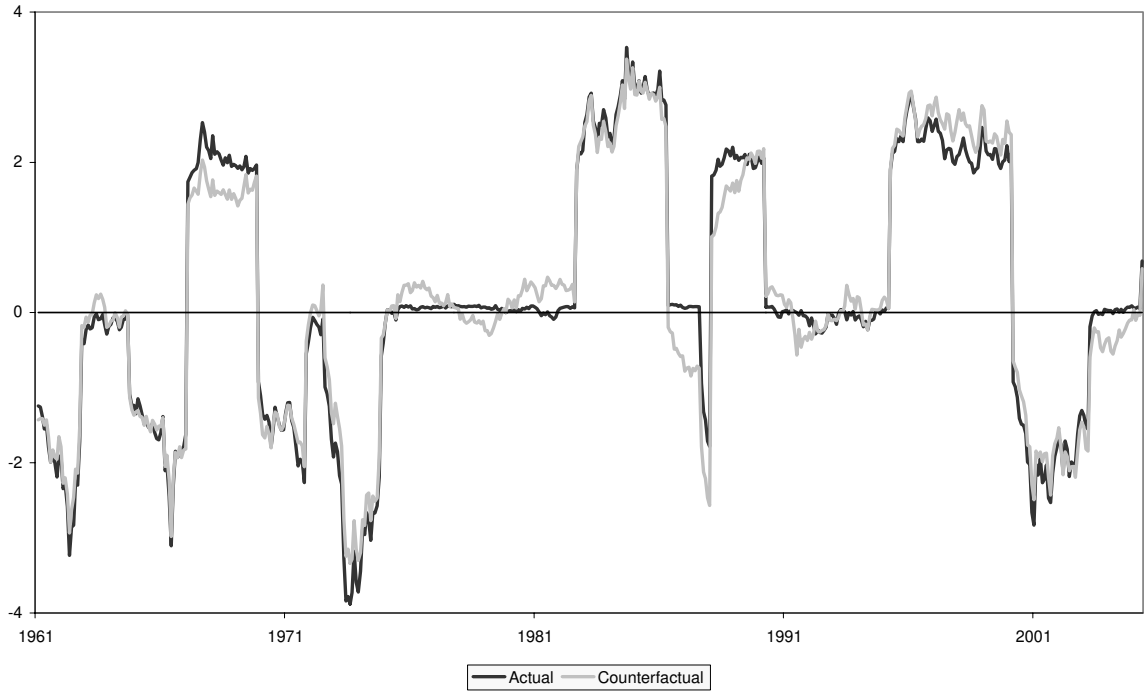

Figure 28: Germany Counterfactual Simulations - Stock Market Conditions Without Long Rate Shock

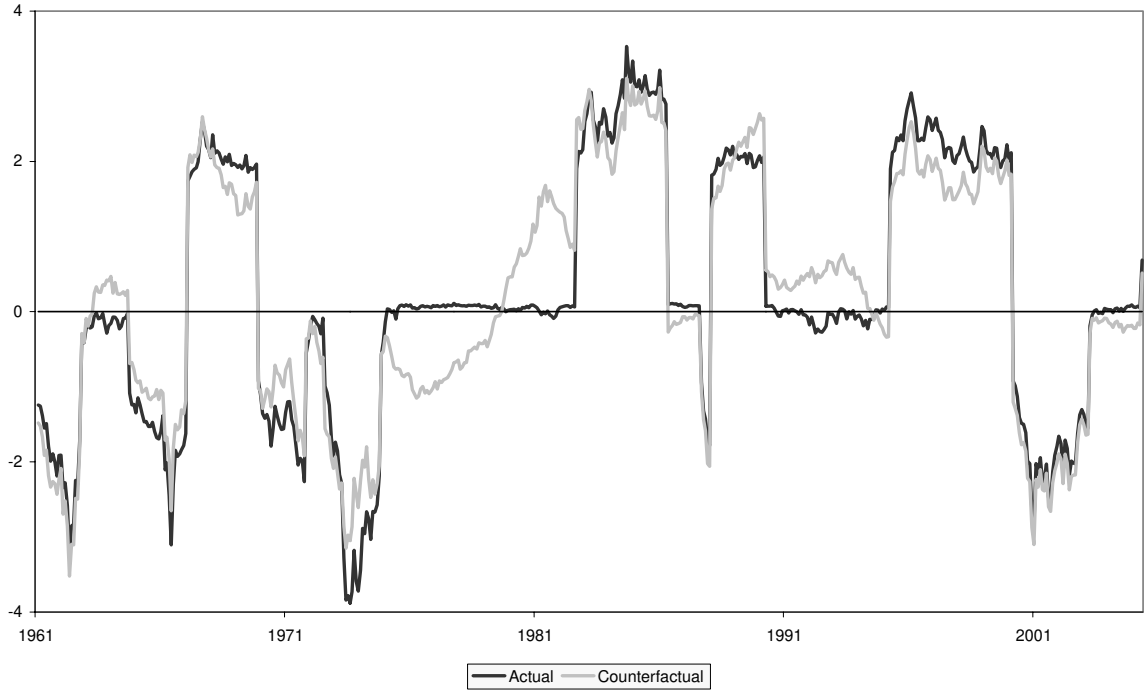

Figure 29: Germany Counterfactual Simulations - Stock Market Conditions Without US Stock Market Conditions Shock